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Soil Survey
of
Oscoda County, Michigan

By

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and

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Bureau of Chemistry and Soils

In cooperation with the
Michigan Agricultural Experiment Station
and the
Michigan Department of Conservation

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SOIL SURVEY OF OSCODA COUNTY, MICHIGAN

By J. O. VEATCH, Michigan Agricultural Experiment Station, in Charge, L. R. SCHOENMANN and C. E. MILLAR, Michigan Department of Conservation, and A. E. SHEARIN, United States Department of Agriculture

INTRODUCTION

During the early occupation of the section of Michigan in which Oscoda County is located, the land was valued chiefly for the timber. The forests consisted of fine stands of red (Norway) pine and white pine; hardwoods, mainly hard maple, beech, and yellow birch; and swamp forests, mainly white cedar, spruce, and balsam fir. Lumbering on a large scale began about 1870 and proceeded so rapidly and destructively that no large tracts of merchantable timber remain. Following lumbering the land was occupied by farms to only a small extent, and in 1930 only about 11 percent of the county was in farms, about 4 percent of which was in cultivated crops. The scant use of the land for agriculture may be accounted for in part by the type of original ownership of the land, namely, large holdings; by the absence of industries other than lumbering; by a small local population; by the great distance from outside markets; and by a none too favorable climate; but mainly because the greater part of the soil is of poor quality and therefore unsuited for the production of some of the staple general farm crops. The growing season is short, and climatic conditions are unfavorable for growing corn as a grain crop or for commercial orchards, but the climate does not prevent maturity and good yields of small grains, hay, alfalfa, potatoes, small fruits, and common garden vegetables in places where the soil and surface relief are favorable. The surface relief is, in general, favorable for agriculture, as most of the land is level or gently rolling, less than 5 percent is nonarable because of steepness of slope or excessive stoniness, and only about 10 percent is wet or swampy.

About 45 percent of the area of the county is composed of deep dry sand soils, mainly of the Grayling types, occupying level or gently rolling plains which were originally covered by pine forests. Some of this kind of land has been cleared for farming at various times, but such ventures have generally been attended with poor success or with complete failure. The sands are not high in elements of fertility, but deficiency in moisture is the chief limiting factor in crop production. A second type of poor land, occupying a large aggregate acreage, consists of deep sand and light sandy loam soils on the hills or plateaulike highlands. This land was also largely occupied by pine, but in a few places there was some admixture of hardwoods. These soils, as a whole, are somewhat more fertile, especially the light sandy loams underlain by more clayey drift, than those of the sand plains, but they are not durable under cultivation

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and in places have the disadvantage of steep slopes. About 5 percent of the county consists of swamp or flat, poorly drained land composed of both organic and mineral soils. The organic soils offer little possibility of agricultural use because of their location and the unfavorable climate.

The soils of the naturally well-drained land, which have been or probably can be utilized for agriculture with some degree of success, consist of the clays, loams, and sandy loams, which were originally occupied by hardwood forest. Two areas occurring in the central part of the county a few miles north of Mio and a smaller body near Luzerne constitute the principal developments of these heavy soils. The land is level or gently rolling, with very few excessively steep slopes, but it includes numerous wet swales and hummocky and rolling patches of sand. The so-called " clay " soils, Nester silt loam and Selkirk silt loam, are moderately fertile and durable. Other less productive soils are mixed with these more clayey soils, but the land as a whole is adapted to hay, small grain, and a dairy type of farming. Sandy loam and sand soils underlain by a coarse limy glacial drift and having rolling and hilly surface relief occupy a small acreage in the northern part of the county in the vicinity of Comins and Fairview. The land in places is stony and steeply sloping, but the sandy loams, as a whole, are moderately productive and adapted to hay, small grain, alfalfa, potatoes, and small fruits. These soils, mainly Emmet sandy loam and Emmet loamy sand, are easily tilled when once cleared of stumps and stones, but they are not durable under cultivation, especially the areas on the steep slopes.

An inventory of the land resources, based chiefly on the inherent characteristics of the land, indicates that 80 percent or more of the total area of the county offers little possibility for utilization for staple cultivated crops and only limited use for extensive grazing. The allocation of this land for State and National forests, game refuges, private hunting grounds, parks, and other recreational purposes appears to be the best solution of the problem of finding a rational use for it.

On the other hand, the better soils, comprising about 20 percent of the total area, have not yet been fully utilized for agriculture. Fair land remains available for farms of a self-sustaining type as economic conditions justify their utilization. A small additional number of part-time farms may be established if supplemental work in State and National forests is available and if the development of lakes and streams for recreational purposes or any other purpose affords auxiliary employment for farm operators.

COUNTY SURVEYED

Oscoda County is in the northeastern part of the Lower Peninsula of Michigan (fig. 1). It lies inland about 30 miles from Lake Huron. Mio, the county seat, is located in the central part of the county. It is 206 miles by automobile highway north of Detroit and 100 miles north of Saginaw. The area of the county is 570 square miles, or 364,800 acres.

Physiographically the county is a part of a highland plain built up by a great thickness of glacial deposits. Within this county the highland plain is bisected, east and west, by Au Sable River which flows through a terraced valley about 3 miles wide and lying from 200 to 400 feet below the highest parts of the upland. Both the northern and southern sections, or plateaus, have much the same physiographic character and surface configuration. On each there are three major relief features and land divisions, namely, smooth sand and gravel plains, broad swells and hills of sandy land, and level or undulating wet and dry clay plains. The greater part of the land is comprised in high, dry, sandy and gravelly plains, most of which are level and lack any conspicuous surface features or great local differences in elevation, although in places they are broken by pits and by long dry valleys or swales. The higher lying masses of hilly plateau land rise gradually or abruptly from the sandy plains, and they consist of broad swells with long, smooth slopes, but locally they are rough in aspect, as the land is characterized by domes, knobs, ridges, and comparatively deep potholes, lake basins, and large constructional flat sandy basins or valleys. Local differences in elevation may be 100 feet or more. The clay plains are smooth or undulating and they include shallow swales and hummocky swells of sandy land and here and there some stream dissection and some small and irregular spots of wet land, but on the whole there is no conspicuous relief or great difference in altitude.

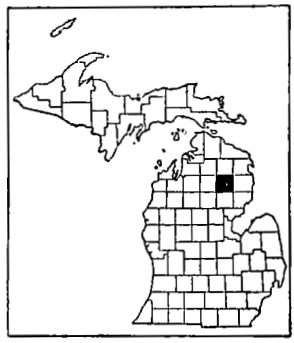

FIGURE 1.—Sketch map showing location of Oscoda County, Mich.

Au Sable River is bordered by three narrow sandy and gravelly terrace plains which are not everywhere continuous and sharply defined. The first lies from 10 to 15 feet above the river or present narrow flood-plain bottom; the second, from 35 to 40 feet; and the third, probably from 70 to 80 feet. The terrace plains are composed of beds of loose stratified sand and gravel, ranging from 6 to more than 15 feet in thickness and resting on reddish-brown or chocolate-colored clay which in places appears to be of lacustrine origin.

The land surface is constructional and probably remains. in its topographic aspect, very much as it was left at the close of the last period of glaciation. The more level areas are parts of outwash plains and clay till plains, and the high hills are land-laid or terminal moraines. Swamps occur both on the level plains and in basins in the hills, but they are not so extensive as in most other counties in the State. There are 122 lakes, principally in the north half of the county. They range in size from less than 1 acre to nearly 250 acres, but most of them are less than 40 acres in extent. There are comparatively few streams, because of the youth of the land surface and the large areas of level land underlain by pervious sand and gravel. The streams flowing into Au Sable River have incised narrow trenchlike valleys, enclosed by bluffs or scarps, from 50 to 100 feet below the plains through which they flow, but since there are so

few small tributary streams the total area affected by stream cutting is small.

The general elevation ranges from 1,000 to 1,200 feet above sea level; small areas in the central and northern parts lie between elevations of 1,300 and 1,400 feet, and the lowest established elevation, on Au Sable River at the eastern county line, is about 900 feet.

The entire land area, with the exception of a small acreage of bog or marsh and some open land on the drier sand plains, at the time of its first occupation by white men, was covered by a dense forest. Lumbering of pine on a large scale began between 1870 and 1880 and of hardwoods about 1900. At the present time (1931) the original forest, with the exception of a few small tracts of virgin hardwood, has been cut over. Several types of forest or tree associations were represented in the virgin forest as follows: (1) The hardwood forest in which sugar maple (*Acer saccharum*), beech, yellow birch, and hemlock were the dominant species; (2) the mixed deciduous-coniferous forest, in which such species as elm, ash, red maple, aspen, and yellow birch were intimately associated with white pine, hemlock, spruce, and fir; (3) the pine forests, in which white pine and red (Norway) pine or red and jack pine predominated; and (4) the swamp forests, in which the dominant species were arborvitae, black spruce, balsam fir (*Abies balsamea*), and tamarack. Much of the original forest land presents a desolation of charred tree stumps and trunks, with a dense growth of brush, briers, and grass on the more recently cut-over and less severely burned land. Most of the older cut-over land has grown up to aspen, oaks, cherry, jack pine, and red maple, with but very little natural reproduction of the original dominant species, except on some of the hardwood land. In places in the swamps the forest remains intact, but most of this land has also been culled over or logged off and, in places, desolated by fires. Some of the dry sandy plains land supports a scattered or dense growth of jack pine. In places where the trees are scattered, the land is covered with a growth of low blueberries (mainly species of *Vaccinium*), sweetfern (*Comptonia asplenifolia*), and bracken, together with various grasses, the most common of which are Canada bluegrass (*Poa compressa*), oatgrass, locally called "buffalo" grass (*Danthonia* sp.) and little bluestem (*Andropogon scoparius*). The bogs are covered with a dense growth of heath shrubs, such as blueberries, leatherleaf, and Labrador-tea (*Ledum* sp.), with some scattered black spruce and tamarack; and in places the marsh growth consists of various sedges and bluejoint (*Calamagrostis canadensis*).

An abundant supply of healthful water can be obtained from wells less than 100 feet deep throughout the greater part of the county. Streams are perennial in flow and carry clear water. There are only a few springs, and these are of little consequence as sources of water supply.

In 1910, at the time of the peak of lumber production and the peak of agricultural settlement, the population of Oscoda County, all classed as rural, was 2,027, or 3.5 people to the square mile, but in 1930 it had decreased to 1,728 or 3 persons a square mile. This county is the least thickly settled of the Michigan counties. The population of Mio, the county seat, was 204 in 1930.

Lumbering has greatly declined and, although still carried on, is a comparatively unimportant industry. A few small portable

mills are still operating. Agriculture has replaced lumbering to only a very small extent, and no manufacturing industries have been established. The attractiveness of the country for hunting and fishing and for summer cottages and camps on the lakes and streams is a commercial asset which brings in a large transient population during the summer and fall.

No railroads pass through the county, but two State trunk-line highways provide good gravel roads for automobile traffic. The main roads are passable throughout the year, except at such times during the winter when they are filled with snow. The more remote sections can be reached only by unimproved roads, but no part is entirely inaccessible.

CLIMATE

The main features of the climate are an average annual precipitation of nearly 29 inches (including melted snow), an average annual snowfall of 56.5 inches, a mean annual temperature of 42.2° F., rigorous winters, short mild summers, fairly high humidity, a large number of cloudy days, small percentage of possible sunshine, and low evaporation of moisture. This county is so far inland from Lake Michigan and Lake Huron that the climate is modified to much less extent than counties bordering these lakes.

The precipitation is fairly well distributed throughout the year. The rainfall occurs mostly as slow and prolonged rains or as frequent showers but rarely as destructive downpours. Ordinarily the amount is ample for the production of the staple crops grown, except on the more pervious and nonretentive sand soils, as evaporation is comparatively low and extended periods of drought are rare. Hailstorms are of very infrequent occurrence, and practically no injury is done to crops by high winds.

The snowfall is heaviest from November to March, but light falls and flurries may occur as late as May and as early as September. A blanket of snow, which affords protection to fall-sown grain, may be depended on during the winter.

The temperature records show extremes higher in summer and lower in winter than in counties bordering Lake Michigan and Lake Huron. There is a range of 155° from the minimum temperature recorded in winter to the maximum in summer, but the extremes in temperature probably have very little direct influence either on the health of the residents or on agriculture, since they are not frequent and do not last very long. The average frost-free season, as shown by the average dates of the last killing frost, June 5, and the first, September 14, is 101 days. It should be understood, however, that hay, small grain, and many native plants may start and continue growth before and after the dates of killing frosts as given by the Weather Bureau. Killing frosts have been recorded in every month of the year.

Corn does not always reach maturity, as the growing season is short and the cool nights are unfavorable to its growth, but, by the selection of hardy and early maturing varieties, grain may be produced, and the crop always yields some forage or silage. In the swales or low places and in wetter situations, all crops are susceptible to damage from late spring freezes and from both summer and autumn frosts. Occasional losses in handling potatoes, one of the

chief cash crops, may be expected because of very cold weather in October, but ordinarily there is sufficient time to harvest this crop and all others grown before extremely cold weather and heavy snows set in.

The maximum number of cloudy days occurs in the winter and spring. The summer season is characterized by a large number of clear days and a fairly high percentage of the possible sunshine.

The data in table 1, compiled from records of the United States Weather Bureau station at Mio, in the central part, are, with slight exceptions, representative of climatic conditions throughout the county.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Mio, Oscoda County, Mich.*

[Elevation, 1,000 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1925)	Total amount for the wettest year (1897)	Snow, average depth
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	22.9	52	−24	1.85	0.94	3.62	11.8
January	17.2	50	−35	1.56	.62	3.41	13.9
February	16.5	63	−47	1.53	.50	1.62	10.1
Winter	18.9	63	−47	4.94	2.06	8.65	35.8
March	27.0	70	−28	2.12	.71	3.12	8.2
April	40.4	87	−23	2.32	1.49	5.56	5.4
May	52.7	96	17	2.91	.37	3.33	.7
Spring	40.0	96	−28	7.35	2.57	12.01	14.3
June	62.8	100	27	2.83	1.58	1.66	0
July	66.5	108	31	3.04	2.49	3.73	0
August	63.8	99	31	2.85	2.44	3.48	0
Summer	64.4	108	27	8.72	6.51	8.87	0
September	57.1	93	23	2.67	3.08	1.62	(1)
October	45.8	86	5	2.56	1.48	3.87	.7
November	34.1	70	−6	2.22	1.40	1.68	5.7
Fall	45.7	93	−6	7.45	5.96	7.17	6.4
Year	42.2	108	−47	28.46	17.10	36.70	56.5

[1] Trace.

AGRICULTURE

The history of the settlement of Oscoda County and of the agriculture are closely connected with lumbering, which began on a large scale in the decade 1870–80. The first land to be logged over was that covered by pine forests, and most of the pine trees were removed by 1890. The lumbering of hardwoods and swamp timber followed, but this was of less importance because of the comparatively small areas in such forest. The farming population did not increase so rapidly as in counties which had a greater proportion of hardwood timber. The early inhabitants, excluding trappers, came primarily to operate the logging camps and lumber mills, and farming was carried on to only a slight extent. The censuses of 1890 and 1900 show, respectively, 252 and 210 farms in the county, and the

amount of improved land was 7,976 and 8,697 acres, respectively. In 1930 there were 220 farms, about 90 percent of which were operated by owners. A small income was realized by the early farmers through supplying the camps and mills with necessary agricultural products, particularly hay and other feed for work animals. At the same time the farmer could work in the logging camps in the winter and thus add to his income. The first farms were started on the sandier soils, owing to the greater ease of clearing the land, and probably the great number of these earlier established farms have been abandoned.

The total population residing permanently in the county has at no time exceeded 2,027, and only a small proportion has been wholly engaged in, or dependent on, agriculture. At present (1931) the agricultural population is decreasing. Only 11.4 percent of the total area is in farms, and less than 4 percent of the land is in cultivated crops or cleared for plowing. This practical failure of agricultural development may be accounted for in part by the rapidity with which the forest was exploited and the failure to provide for reforestation; in part by the poor quality of most of the pineland for the present-day general-farm crops and methods of farming; and in part by the cost of clearing land, distances from outside markets, and absence of local markets, as lumbering has not been replaced to a considerable extent by other industries.

The early farming included the growing of hay, oats, potatoes, and small quantities of wheat and corn and the raising of some livestock. The tendency during later years has been to devote greater attention to dairying, growing seed crops, poultry farming, and producing special products that can be disposed of locally. The value of all crops produced in 1929 was $131,328.

Table 2 shows the acreage devoted to the principal crops grown in 1919 and 1929 and their average yield for the 10-year period.

TABLE 2.—*Acreage of selected crops grown in Oscoda County, Mich., in 1919 and 1929, and average yield for the 10-year period*

Crop	1919 [1]	1929 [1]	Average acre yield for 10-year period [2]	Crop	1919 [1]	1929 [1]	Average acre yield for 10-year period [2]
	Acres	*Acres*	*Tons*		*Acres*	*Acres*	*Bushels*
Hay	4,673	6,384	1.3	Corn for all purposes	737	317	
Alfalfa [3]	52	1,795		Corn for grain	495	56	32
			Bushels	Rye	1,341	226	12
Oats	2,335	918	28	Wheat	671	155	12
Barley	211	513	25	Potatoes	252	112	98
				Buckwheat	170	20	12

[1] United States census reports.
[2] CHURCH, H. V., and DAY, O. A. CROP REPORT FOR MICHIGAN, ANNUAL SUMMARY FOR 1928. Mich. Dept. Agr. and U. S. Dept. Agr., Bur. Agr. Econ., 52 pp. 1929.
[3] Included with hay.

The more important crops are hay, alfalfa, oats, potatoes, barley, corn, rye, and wheat. Other crops which are or can be grown with some degree of success are buckwheat, field peas, beans, turnips, rutabagas, red clover as a seed crop, sunflowers for silage, and many common garden vegetables.

Hay and forage crops combined occupy a greater acreage than any other field crop, and ordinarily the total value is greater than that of any other crop. The hay is principally timothy and red clover or alsike clover, mixed, but considerable timothy is grown alone. Fairly good yields of red clover are obtained on the better sandy loam and loam soils without liming the land, but this clover apparently cannot be grown successfully on the deeper sands, either on the hills or on the plains. This crop is best adapted to the most fertile, well-drained, heavier textured sandy loams and loams. Ordinarily, only one cutting a year is obtained, and the yield is 1½ or 2 tons an acre on these soils. It is perhaps inadvisable to attempt to grow alfalfa on the lighter, drier, and more acid sands, such as the Grayling, Roselawn, and Rubicon, without heavy manuring, liming, and fertilization. The acreage of sweetclover has increased during the last few years, and this crop can perhaps be successfully grown on much of the hilly sandy land. Other crops grown for forage are corn, rye, oats, barley, and vetch, and they are consumed mainly on the farms where grown.

Corn is grown principally for forage and silage, although the corn from about 500 acres was used for grain in 1932. Both dent and flint varieties are planted. This crop is susceptible to damage from early frosts, particularly in the lower situations. The acreage in rye is increasing, because this crop can be grown successfully on the light sandy soils. It is grown for grain, forage, and as a green-manure crop. Oats, the most extensively grown grain crop, are fairly successful throughout the county on practically all types of soils except the lightest and driest sands. Acre yields ranging from 35 to 40 or more bushels, are obtained on the more productive soils, and the 10-year average on all soils is 28 bushels. Mixtures of oats and barley, also of oats and vetch, are grown. Winter wheat can be grown, but the yields are low, averaging 12 bushels an acre as a 10-year average. Most of the soils are too sandy for wheat, and it can hardly be considered a profitable crop. Buckwheat does fairly well on many soils. It is grown as a cash crop and as feed for poultry and livestock on the farms. The 10-year average on all soils is estimated at 12 bushels an acre.

Potatoes are a cash crop throughout all sections. They can be grown most successfully on the better sandy soils. The average yields under present conditions are not high (98 bushels an acre), but the potatoes are of good quality. Navy or white beans may be grown with a fair degree of success on the clay soils and the better sandy loams. The acreage, however, remains small.

A variety of fruits can be grown throughout the county, but climatic and marketing conditions are unfavorable for extensive commercial production. Apples are the principal orchard fruit. Pears, plums, cherries, strawberries, and raspberries are grown, mainly for home use.

The total value of all livestock on the farms on April 1, 1930, was $324,403, which is nearly three times the value of all the crops produced. The principal sources of income are dairy cattle and dairy products. Sheep are grazed successfully during the summer, and the number kept is increasing. A few beef cattle and hogs are kept

on some farms, but their numbers are decreasing. Extensive feeding or raising of livestock on ranches has not proved successful. Poultry and eggs constitute an important supplementary source of income on most farms.

Table 3 gives the numbers of domestic animals on the farms in 1920 and 1930, as reported by the United States census.

TABLE 3.—*Numbers of domestic animals in Oscoda County, Mich., in 1920 and 1930*

Animal	1920	1930	Animal	1920	1930
Sheep	7,099	10,582	Swine	660	455
Cattle	2,879	2,984	Horses	883	548
Chickens	9,298	8,398			

Liming of the land is not a common practice. Apparently lime is not important for potatoes, and on most of the land under cultivation little difficulty has been experienced in obtaining good stands of red clover without lime. Although liming would very probably be beneficial on all the cultivable land, on the more acid sands, such as Grayling, Rubicon, and Roselawn, lime is considered essential for good yields of red clover and alfalfa. Barnyard manure, where available, is generally used, and green-manure crops, such as rye, are grown for maintaining the productivity of the soil.

Commercial fertilizers can probably be utilized successfully for increasing crop yields, especially of potatoes. Experimental tests at the Michigan Agricultural Experiment Station farm at Grayling, in the adjoining county on the west, indicate that small grains, sweetclover, and alfalfa will also respond to commercial fertilizers, and their use in conjunction with liming and manuring is advised.[1]

Rotation of crops is observed, although no definite plan is generally followed. Perhaps the most common practice is to follow small grain with red clover, and clover with potatoes or corn. Alfalfa and sweetclover are usually followed by potatoes or corn.

The character of the soil has exerted a striking influence on the distribution of the farming population, notwithstanding that this population is very small. There are two farming communities located on the naturally most productive soils, namely, in the vicinity of Fairview and Comins. These and smaller communities and isolated farms are located on the loam soils and soils underlain directly by sandy clay, such as Selkirk silt loam, Nester silt loam, Emmet sandy loam, and Iosco sandy loam. Dry level sand soils and rolling or hilly sand soils, such as Grayling sand and Roselawn sand, are either unused for any purpose or are very sparsely occupied and show the greatest number of abandoned farms and fields. About 7 percent of the crop land in the county is idle or fallow. The heavier soils are best suited to dairying and general, or diversified, farming, as the greater part of the timothy, clover, corn, oats, wheat, and field peas produced are grown

[1] MCCOOL, M. M. and WEIDEMANN, A. G. THE SOILS OF MICHIGAN—GRAYLING SAND. Mich. Agr. Expt. Sta. Spec. Bull. 180, 24 pp., illus. 1929.

on this kind of land. It is recognized that rye can be grown with greater success than wheat, barley, or oats, and that timothy is more successful than red clover on the lighter sandy soils. Potatoes can be more successfully grown on hilly or sloping light sandy loam soils, such as Emmet sandy loam and Roselawn sandy loam, than on the wet sands or on the dry sands of the pine plains.

According to the farm census figures for 1930, only 11.4 percent of the land in the county is in farms and 32.7 percent of the farm land is in crop land and plowable pasture, that is, actually improved for cultivated crops. The average size of the farms is 191.8 acres, but the improved land averages only 62.8 acres a farm. The small individual holdings are for the most part in 40-, 80-, and 160-acre tracts. Lots and small subdivisions are laid out around some lakes and along Au Sable River. The virgin forest and the wild cut-over land is for the most part still held in large tracts by the lumber companies, by hunting and fishing clubs, and by land companies for speculative purposes. The State owns or controls 61,891 acres [2] which is largely in forest reserves, and in addition most of the southern half of the county is included in the Huron National Forest.

As such a large proportion of the total acreage is uncultivated or is idle and unused, some sort of classification of the land is necessary in order to determine its value and possible utilization for some productive purpose. The classification given in table 4 is based primarily on the soil type, as the soil type implies not only the physical and chemical character of the soil but in addition more or less uniformity in relief, drainage, and native vegetation. Future economic conditions cannot enter into a classification, because they are not known, nor can possible future discoveries in agricultural science be taken into account. Changes in either must obviously affect the value of the land and its agricultural possibilities.

It is apparent that, under present economic conditions, a very large acreage of land in this county is of little agricultural value and is not being utilized other than for the meager grazing it provides or for resort and recreational purposes. Some of this nonfarming land, however may be utilized for growing trees by the State or National Government, at least until there is some real social or economic need for the land for homes and farms. Practically all the land suitable for farming under existing conditions is occupied, so that there appears to be little probability of extensive agricultural development of new land.

A broad agricultural classification showing the present (1931) agricultural condition and the extent of occupation of the land in Oscoda County is set forth in table 4. It must be remembered, however, in the land classification here shown, that the classes of land are relative only as applied to this county. First-class land here is not exactly comparable to first-class land in other parts of the United States or even to first-class land in other parts of Michigan.

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[2] FONTANNA, S. G. DIVISION OF LANDS. Mich. Dept. Conserv., Bien. Rept. (1928–30) 5. 1930.

TABLE 4.—*Agricultural classification of land in Oscoda County, Mich.*

Soil type	Approximate area	Class and description	Present condition and use
	Acres		
Greater parts of Selkirk silt loam and Nester silt loam, very small acreage of Emmet sandy loam and Roselawn sandy loam.	12,000	1. Moderately fertile, productive, and durable soils; stone free or not excessively stony: not excessively hilly for general farming; retentive clayey subsurface layer; first-class or fair pasture where cleared of brush and second-growth trees.	Greater part in small farms; farming not highly prosperous but comparatively successful; estimated that from 60 to 75 percent is cultivated; remainder in second-growth hardwood forest or stump pasture.
Greater parts of Emmet sandy loam and Roselawn sandy loam, Ogemaw sandy loam, Bergland clay loam, Munuscong sandy loam, Kalkaska loamy sand, Granby gravelly sand, and Iosco sandy loam.	42,000	2. Low or medium natural fertility; deep clayey subsurface layer, in part wet, in part dry and well drained; ranges from moderately hilly and sloping to flat; not excessively stony; reclamation possible within practicable cost; pasture value from fair to good; marginal farming and farms which provide homes but only a part of the income for family living.	Estimated that less than 5 percent has been cleared and placed under cultivation; limited use for potatoes, grain, and hay crops; wild land mainly in pine stumps with second-growth aspen, oaks, and other hardwoods; in part in virgin hardwoods and recent slashing; swamp land thickly set with stumps or culled-over swamp hardwoods, fir, cedar, and spruce.
Greater parts of Emmet loamy sand and Roselawn sand, Grayling sand, Rubicon sand, Saugatuck sand, Newton sand, Griffin sandy loam, Griffin loam, peats, and mucks.	312,000	3. Low or medium fertility; very dry or excessively wet and swampy; land lowest in assessed valuation, and either submarginal for farming or nonagricultural under present conditions.	Estimated that less than 1 percent is in cultivation; large percentage of farm land abandoned; State forest reserves; except parts of swamps, all is cut-over land; poor or fair oaks, aspen, and pines on dry sands; peats for the most part densely covered with tree and shrub vegetation.

All the land not occupied by virgin forest or having special value for the tourist and resort business is comparatively low priced. The average assessed valuation of farm land, including buildings, was $24.63 an acre in 1930. The lowest assessed valuation for all land is placed on unused cut-over land, such as is embraced in Grayling, Rubicon, Saugatuck, and Roselawn sands, and the highest valuation is placed on the sandy loams and clays.

SOILS AND CROPS

The soils of Oscoda County comprise a large number of distinct types, but they do not, however, show quite so wide a range and diversity in texture, structure, chemical composition, fertility, and moisture content as soils in most of the other counties of the State. Although they show in places that lack of uniformity—textural and other variations within very short horizontal distances—common to the soils of Michigan, there are some very large bodies of soil that are comparatively uniform.

The surface layers, exclusive of forest litter and humous soil, range in texture from loose, incoherent, nearly pure sand to silty loam and clay loam. The greater part of the mineral soils are sands and light sandy loams to a depth of 3 feet or deeper. The sands comprise 75.7 percent of the total area of the county and the sandy loams 13.6 percent, whereas those soils which would have a loam, silt loam, or clay loam texture in the plow soil if cultivated, comprise only

about 4.2 percent. The greater part of the land, exclusive of swamp, is arable. It is estimated that less than 5 percent is nonarable or difficult to manage because of the extreme stickiness and toughness of the clay, extreme stoniness, susceptibility to blowing, and excessively rough relief and steep slopes. About 6.5 percent consists of muck and peat, which have their own peculiar physical characteristics and problems of management, but in Oscoda County they have practically no value for cultivated crops at present, mainly because of the short growing season.

The content of organic matter in the plow layer of the greater part of the upland soils is, or would be, if cultivated, comparatively low. The forest mold layer of the virgin well-drained soils is, or was originally, nearly everywhere thin, not exceeding 2 or 3 inches, and in some soils is so thin as to be scarcely measurable. Some of this organic matter is lost in clearing the land, and that remaining is not durable under cultivation, especially in the sands. The soils are penetrable to a great depth, as the underlying material is unconsolidated glacial drift.

Probably 98 percent of the soils are acid in reaction in the surface layer of mineral soil or in the plow layer. It is estimated that about 85 percent are acid to a depth ranging from 36 to 40 or more inches; from 10 to 15 percent are strongly acid in the surface soil but contain sufficient calcium and magnesium carbonates, or sufficient limestone gravel, at a depth ranging from 24 to 36 inches to give an alkaline reaction; and that less than 2 percent are not acid in the surface layers under natural conditions. The organic soils are nearly everywhere medium or strongly acid and are mainly peats, with scarcely any of the well-decomposed so-called "high-lime" mucks common in the southern part of the State.

Most of the soils are naturally fairly well drained, as the water table is not high and the slope is sufficient to provide free run-off. A large percentage of the land is characterized either by a high water table or by a permanently swampy condition.

The natural fertility and productivity of the soils, according to the standards for Michigan, are in general medium or low. Although analyses of the dominant soil types in this county do not show evidences of abnormally small amounts of the mineral constituents ordinarily determined, much of the soil is poor because of a combination of low or only medium content of plant nutrients and a deficiency of moisture, as in the pine-plain sands. Much of the land is poor because of the low content of mineral plant nutrients and excessive water, as in some of the peats and swamp-border mineral soils such as Saugatuck sand and Newton sand. The short growing season prevailing throughout the county makes otherwise productive soils less productive.

For purposes of mapping and correlation, soils are grouped in series on the basis of common characteristics of color, consistence, texture, chemical composition, and thickness of the whole soil and of the separate layers. A soil series is divided into soil types, the unit of mapping, on the basis of texture of the surface soil, or plow layer, of mineral soils. Each soil series is given a geographic name for convenience of reference and description, and each soil type is further distinguished by an additional texture class name.

In interpreting or drawing conclusions from the soil map it should be understood that soil types grade into each other where they join. Therefore, sharp lines of demarcation are not to be expected. Variations occur in each soil area shown, especially in the hills, so that each soil color on the map must be understood to represent a dominant soil condition in a complex and not a single type of soil strictly uniform in every respect. The amount of detail which can be shown is, of course, limited by the scale of the map. The scale here employed is 1 inch to the mile, and on this scale it is not generally practical to attempt to locate separate bodies of soil less than 5 acres in extent.

The soils are described from the point of view of their practical agricultural significance and in relation to other uses of the land, and their morphology, classification, and genesis are discussed in a subsequent section. The soil types are described in relation to the following natural land types which are recognized on the basis of the outstanding physical characteristics of the land, including the character of the soil, relief, drainage, and native vegetation. (1) Sand soils of the dry pine plains, occupying the level or undulating dry plains; (2) sandy soils of the pine hills, occupying the rolling and hilly highland; (3) sandy soils of the hardwood upland, light sandy loams and sands occupying the hardwood hills and plateau upland, including dry sandy valleys; (4) soils of the rolling clay lands, silt loam soils occupying the hardwood and mixed hardwood and pine uplands; (5) mineral soils of the wet lands, bordering peat swamps; those occupying flat and rolling plains underlain by clay; and wet alluvial valleys; (6) organic soils, peat and muck soils of the swamps and marshes.

The acreage and proportionate extent of the different soils mapped in Oscoda County are given in table 5; their location and distribution are shown on the accompanying soil map, and a description of the individual soil types in their relation to agriculture is given in subsequent pages of this report.

TABLE 5.—*Acreage and proportionate extent of the soils mapped in Oscoda County, Mich.*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Grayling sand	108,544	29.7	Saugatuck sand	2,496	0.7
Grayling sand, gravelly phase	16,000	4.4	Ogemaw sandy loam	5,952	1.6
Grayling loamy coarse sand	2,880	.8	Bergland clay loam	2,240	.6
Rubicon sand	17,472	4.8	Munuscong sandy loam	4,736	1.3
Rubicon sand, gravelly phase	12,288	3.4	Granby gravelly sand	256	.1
Roselawn sand	50,752	13.9	Griffin sandy loam	576	.2
Roselawn sand, gravelly phase	45,376	12.4	Griffin loam	2,240	.6
Roselawn sandy loam	12,416	3.4	Rifle peat	18,304	5.0
Emmet sandy loam	20,416	5.6	Lupton muck	512	.1
Emmet loamy sand	13,312	3.6	Greenwood peat	1,408	.4
Kalkaska loamy sand	2,304	.6	Kerston muck	960	.3
Selkirk silt loam	7,936	2.2	Houghton muck	2,560	.7
Nester silt loam	2,880	.8			
Iosco sandy loam	5,376	1.5	Total	364,800	
Newton sand	4,608	1.3			

SAND SOILS OF THE DRY PINE PLAINS

Sand soils, which originally supported forests of red pine, jack pine, and white pine, occupy a large aggregate acreage. They occur

in large bodies in the southern half and western parts of the county and in small bodies throughout all sections. Most of the land consists of dry level plains, but in places these are pitted and slightly rolling or billowy. The original pine forest was cut from 40 to 50 years ago, and the land is now partly occupied by jack pine and oaks and a scattered growth of red pine, but much of it, partly owing to repeated burning, is treeless and open in aspect, dotted with stumps, and characterized by a ground cover of grasses, blueberries, bracken, sweetfern, mosses, and lichens, together with a low shrubby growth of aspen, fire cherry, willow, and service berry.

In addition to the broad plains, low sand ridges are widely distributed throughout the swamps and lower lying lands, which originally supported pine. Most of the soils of the pinelands are deep loose sands, low in moisture and fertility, and consequently of little or no agricultural value.

Grayling sand.—Grayling sand comprises the deep yellow sand soil of the drier pine plains. The distinguishing characteristics of this soil are its looseness and incoherence, or single-grain structure, and its pervious nonretentive character to a depth of 6 feet or deeper. The average content of moisture is low, and the fertility is low. The reaction ranges from medium to strongly acid to a depth of more than 4 feet.

This soil is fairly uniform throughout the county, but there are some slight variations in the texture of the sand and in the quantity of gravel in the soil. These variations may have some significance, though perhaps slight, in relation to average moisture content and plant nutrients affecting plant growth. In the open grass-covered areas, the thickness of soil colored by humus or organic matter is appreciably greater and the tint is darker than in the soil under jack pine or oaks, but the humus layer is extremely thin under any conditions.

Grayling sand is one of the more extensive soils in the county. It occurs in large bodies in the northwestern part and includes much of the dry level sandy land in the central and southern parts.

The land, though level, is well drained or dry, owing to the perviousness of the soil and the geological formation underlying it.

The native tree growth on this soil probably consisted mainly of red pine and jack pine, and there were a few white pine and oaks. The present growth is mainly of jack pine, occurring in thickets or scattered, in association with small oaks and aspen. In the more open areas the characteristic and more common shrubs and herbs are blueberry (*Vaccinium* sp.), low willow (*Salix humilis*, Marsh), sweetfern (*Comptonia asplenifolia*), bracken, a sedge (*Carex* sp.), a species of bluegrass (*Poa* sp.), wild oatgrass (*Danthonia*), and bunchgrass (*Andropogon* sp.).

Grayling sand has very little agricultural value under present economic conditions. A few small farms are, and have been in the past, located on this soil, but attempts made to cultivate the land have been attended with little success. The chief deficiency of the soil is a low content of moisture during the growing season, in addition to low or only moderate fertility and high acidity. On the basis of several years' experiments at Grayling, Mich., on this type of soil, it has been demonstrated that by the liberal use of manure or the

growing of green-manure crops, by liming, and by applying fertilizers, it is possible to obtain fair yields of sweetclover, alfalfa, potatoes, turnips, rye, and other crops.[3] Thus it would seem that, under exceptional conditions and by following scientific methods, possibly some of the land could be successfully used for cultivated crops, but for the greater part, a reasonable labor income can hardly be expected in competition with naturally more productive or more favorably located soils in this and other States. Sheep and cattle may be pastured, but the pasture value of the land is low, as there are few valuable forage plants other than grasses, and these become dry and unpalatable in late summer or early fall. The most logical use of the greater part of this land seems to be for forestry and recreational purposes. The surface relief and character of the soil favor comparatively low cost in tree planting and forest management, but the land can hardly be given a high rating for forestry purposes because of deficiency in soil moisture and slow growth of trees other than jack pine which in places is of sufficient size and density to have some value for paper pulp and fuel wood. Wild blueberries will provide some income from such land if given protection from destructive picking.

Grayling sand, gravelly phase.—The gravelly phase of Grayling sand differs from the typical soil mainly in its greater content of coarse sand and gravel on the surface and throughout the soil. The higher gravel content may indicate a greater diversity of minerals entering into its composition, and this soil may be slightly more loamy, a little more fertile, and produce a thriftier tree growth than typical Grayling sand. The relief, drainage, and native vegetation are similar on the two soils, and the classification for agricultural utilization is the same, namely submarginal or poorly suited even for subsistence farming.

Grayling loamy coarse sand.—Grayling loamy coarse sand differs from Grayling sand chiefly in texture. It is slightly more loamy in the surface layers and on the whole exhibits a little more fine reddish-brown or brown clayey matter in the subsurface layer, especially in the more gravelly areas. The difference in these respects is reflected in slightly better growth of plants, but it is not sufficient to materially increase the agricultural value of the soil, since low moisture is still the limiting factor. This same feature may give this soil a slightly higher rank for forestry. The surface relief and native vegetation are about the same as for Grayling sand. The more gravelly and cobbly areas are indicated on the soil map by appropriate symbols.

Rubicon sand.—Rubicon sand is characterized by a surface layer of somewhat gray loose harsh sand from 3 to 6 inches thick, underlain by dull-yellow sand which ranges from soft and earthy to slightly cemented and extends to a depth ranging from 18 to 30 inches. Loose gray or faintly salmon colored sand extends to a depth of several feet before the water table or a clayey substratum is reached. The thickness of the dark-colored humous soil, in the virgin condition, is scarcely more than one-half inch, and the underlying sand is acid and low in fertility.

[3] McCool, M. M., and Weidemann, A. G. See footnote 1, p. 9.

The original forest growth was chiefly white pine and Norway pine, with a small admixture of the common hardwoods, especially near the boundaries of associated wetter or more clayey soils. The land now contains the stumps of the original pines, and the tree growth consists of aspen, red maple, service berry, and fire cherry, together with clumps of jack pine and a few individual white pines and red pines. The ground cover consists mainly of sweetfern, blueberries, bracken, wintergreen, mosses, and lichens, and locally a fair cover of native grasses and sedges.

The land is arable, and the relief is favorable, but, on account of low fertility and excessive dryness at times, the soil has very little agricultural value. The statements made as to the possible agricultural use of Grayling sand apply also to Rubicon sand. The pasture value is only fair. Tree growth is apparently slow, but a little more rapid and greater volume of growth than on the Grayling soil may be expected, because of the slightly higher content of moisture.

Rubicon sand, gravelly phase.—The more gravelly areas of Rubicon sand are indicated on the soil map as a gravelly phase. The soil is apparently a little more loamy or has slightly more fine material in the subsurface layers, but this fact has little agricultural significance here, because of the small size of the separate bodies.

SANDY SOILS OF THE PINE HILLS

The soils of the rolling and high plateaulike uplands, originally occupied mainly by pine forest, are principally deep, dry, incoherent, somewhat yellow, acid sands. In surface appearance, the soils are very similar to the sands of the pine plains, but, on the whole, they are a little loamier, and pockets or thin layers of clayey drift are more common at a depth within reach of plant roots. In association with the prevailing deep sand soils of the slopes and crests of ridges or high knolls are patches of gravelly soils, spots of soils having red friable clayey sand at a slight depth and marked by a greater proportion of hardwood trees, and dry valleys and swales containing soil in all essentials the same as the Grayling sand, and some soil containing wash from the adjacent slopes and hence being higher in fertility. The soil in these swales, or depressions, generally supported a larger proportion of white pine.

The soils of this land division are embraced in Roselawn sand and Roselawn sandy loam. The included Grayling sand, peat, and wet mineral soils areas are described elsewhere in connection with other land divisions.

Roselawn sand.—Roselawn sand comprises loose yellowish-gray sand which is dry to a depth ranging from 3 to more than 4 feet. The deeper underlying material consists mainly of sand but contains scattered gravel and boulders and in places pockets of clay. The soil is fairly uniform, in that it consists dominantly of a mixture of medium sand and fine sand. The land is for the most part free from stones, but in places boulders and gravel pockets occur.

The content of organic matter is uniformly low and not durable. Where the soil is grass-covered, as in spots on old cut-over land, the dark-gray color, caused by organic matter, extends to a greater depth than under trees, but it is nowhere thick. The moisture-holding ca-

pacity and the average quantity of water held is low, but it is probable that a high proportion of that present is available. The total quantity of essential plant nutrients, such as calcium, magnesium, phosphorus, and potassium, is lower than in the hardwood sands and clay soils, but there is no evidence of an abnormal deficiency of essential plant nutrients. The low fertility is compensated to some extent by the penetrability of the soil and greater freedom of root development. The reaction is strongly acid to a depth ranging from 3 to 5 feet. The gravelly areas, spots in which some clay is present between depths of 3 and 5 feet, and the dry valleys or swales between hills may be slightly more productive than the typical deep sand.

Roselawn sand is one of the more extensive soils. It occurs on low swells, smooth rounded ridges, and hills, with broad dry swales and valleys intervening. Although streams or natural drainageways are few, the land is dry or well drained, owing to the perviousness of the soil and free downward percolation of water.

The original forest consisted dominantly of red pine, with perhaps a few scattered white pine, oaks, and jack pine. The pine has been entirely cut by lumbermen, and the old cut-over land has grown up to a poor or fair growth of oaks, red maple, aspen, and white birch. A few scattered red pines, remnants from the original forest, and most of the pine stumps left by the lumbermen remain. Bracken, sweetfern, and low blueberry are common, and in places there is a dense thicket of briers.

Only a very small proportion of the land has been cleared for farming. Rye, oats, corn, potatoes, timothy, and buckwheat are grown. Yields are low, and in a number of places cleared land has been abandoned after a few years of hopeless farming. The chief deficiencies of the soil seem to be low average moisture, low fertility, and high acidity. Red clover is not successful, and it does not seem probable that good stands of alfalfa or sweetclover can be obtained without liming. The wild land has a possible value for the grazing of sheep and cattle, as it supports several species of grasses and weeds which are of forage value. The cover of ferns, shrubs, and trees, however, depreciates the value of the land for pasture. Bluegrass dries up in the middle of the summer. The logical use of this land seems to be mainly for forestry, game refuges, and hunting preserves.

Roselawn sand, gravelly phase.—The gravelly phase of Roselawn sand is distinguished from the typical soil by the presence of an appreciable quantity of rounded gravel and small stones on the surface and throughout the soil. The gravel consists of water-worn fragments of granitic rocks, chert, and some sandstone, but very little or no limestone. This gravelly soil occurs in small bodies. It may have a little higher productivity, but its land value and present use are similar to those of typical Roselawn sand.

Roselawn sandy loam.—Roselawn sandy loam is characterized by a light sandy loosely coherent surface layer overlying a mixture of friable pale-red sand and clay material at a depth ranging from 20 to 40 inches. The plow soil of cultivated land is variable in color and texture, but in most places it is gray or light grayish-brown sandy soil containing sufficient silt, clay, and organic matter to pro-

duce a loamy feel and slight coherence. The content of organic matter is low and not very durable under cultivation. The soil is pervious but contains sufficient clay to check slightly the free downward movement of water, and it therefore retains a little more water for plant use and has slightly higher natural fertility and greater potential productivity than the Grayling and Roselawn sands. The soil is medium or strongly acid in all layers to a depth ranging from 3 to 4 feet. It is not probable, however, that the amount of lime is abnormally low, as calcium carbonate is present in appreciable quantities in the parent drift.

Roselawn sandy loam occurs mainly in the northeastern, northwestern, and southeastern parts of the county. In a few places the slopes are steep, but most of the areas are gently rolling, and a part of the land is nearly level.

The original forest cover apparently consisted of various mixtures of the pines (white and red) and the hardwoods, such as hard maple. beech, elm, oaks, and some hemlock.

The old, more severely burned cut-over land is covered with stumps of hemlock and pine, a shrubby growth, consisting of aspen, oaks, sumac, witch hazel, and fire cherry, together with briers and grasses; or it is occupied by a second growth of the original dominant hardwood forest species. Oaks apparently make a more thrifty growth than on Grayling sand and Roselawn sand, with which this soil is associated. A few small plots have been placed under cultivation, but some of the cultivated land has been abandoned during the last few years. The land has some intrinsic value for agriculture, but it is disadvantageously located, and farming is likely to be marginal under present conditions. The smoother land might be used for subsistence or part-time farming.

Where the land has been farmed, oats and rye (planted alone or with vetch), timothy and red clover, corn, beans, buckwheat, and potatoes have been grown. Potatoes are probably the most successful cash crop. The land is naturally not so well suited to red clover, alfalfa, and sweetclover as are the more limy and more fertile soils, but these crops can be grown. Its value for forestry should be higher than that of Roselawn sand.

A number of areas of Roselawn sandy loam, in which there is an appreciable quantity of gravel and stones, both at the surface and in the underlying red sandy clay layer, are indicated on the soil map by gravel symbols. The smoother land has about the same agricultural value as the sandy loam. Some of the included soil consists of a mixture of deep sand and sandy loam, but on the whole, it contains a little more clay at a slight depth than the areas shown as Roselawn sand, gravelly phase. Here and there the ash-gray surface layer appears to be silty, and in such places the soil is probably more fertile than the typical sandy soil. These gravelly areas include some extremely gravelly and cobbly soil which occupies knolls and sharp ridges. Such spots are generally characterized by a thin subsoil layer consisting of reddish clay binding a mass of gravel and sand, and beneath this a coarse pervious bouldery substratum. There are only a few small bodies of such soil, and the more favorably located land has more value as a source of road gravel than for

agricultural use. The more gravelly spots apparently supported a little more vigorous tree growth and had more sugar maple and beech than the associated deep sand and gravel-free soil.

SANDY SOILS OF THE HARDWOOD UPLAND

The sandy hardwood upland is characterized in large part by level and gently rolling surface relief. It is plateaulike, as the smooth land is in places terminated by steep slopes and is intersected by deep valley plains. Some of the land comprises poorly to well defined benches or terrace plains. In other places the topographic aspect is no different from that of the pine hills, but the soils and vegetation differ. The soils appear to have a little more limestone in the parent underlying drift, a little more clay, and the sands especially are characterized by a dark-brown loamy layer containing organic compounds, in places slightly cemented, lying just beneath the gray leached surface layer of mineral soil. The original forest growth consisted of a dense stand of sugar maple, beech, yellow birch, elm, and basswood, with some admixture of hemlock and white pine, especially on the sandier soils.

This kind of land occurs mainly in the central and north-central parts of the county, in the vicinity of Fairview and Comins, with smaller bodies elsewhere. Some of the land is in agricultural use, and small bodies are given a rank of first-class land (on a local basis), but the greater part is marginal agricultural land under present conditions. Most of it, for various reasons, remains uncultivated and occurs either as forest land and recent slashing or as old cut-over land covered with stumps and a scrubby growth of aspen, fire cherry, and oaks. Some of it is cleared but abandoned farm land.

The principal soils in this group are Emmet sandy loam and Emmet loamy sand. The included broad dry sandy valleys are occupied in part by Kalkaska loamy sand which will be described in connection with the Emmet soils. A number of other soil and topographic features are components of this kind of land, but they are described under the land types in which they predominate.

Emmet sandy loam.—Emmet sandy loam comprises most of the better grade soil of the hilly hardwood upland. It is a sandy soil underlain, at a depth ranging from 2 to 3 feet, by clay or by a pervious gravelly or stony sand-clay mixture. The typical soil in forest or cut-over land consists of the following layers: (1) A dark surface layer of mold or a loose mixture of sand and more or less humified organic matter, 2 or 3 inches thick; (2) a light-gray loose loamy sand layer, 2 or 3 inches thick; (3) a dull-yellow or brown loamy sand layer, 4 or 5 inches thick; (4) a pale-yellow or bleached reddish-yellow sandy loam layer; and (5) a limy substratum of gravel, sand, and clay. The presence of sandy clay material at a slighter depth, or with greater frequency is the chief distinction between Emmet sandy loam and Emmet loamy sand. Probably the average amount of moisture held by the sandy loam is higher than in the loamy sand. The soil is commonly acid in reaction down to the clay substratum, except in the more stony and gravelly areas.

This soil occurs in fairly large bodies in the vicinity of Fairview and Comins, in the northern part of the county. Most of the land is not too broken for agricultural use, but locally some steep slopes are too susceptible to erosion to justify the cost of clearing. Boulders and gravel occur in places indicated on the map by symbols, but the soil as a whole is not excessively stony for cultivated crops.

The land originally supported a dense forest of such hardwoods as sugar maple, beech, elm, yellow birch, and basswood, together with considerable hemlock and a few scattered white pine. The unused cut-over land has largely grown up to aspen, pin cherry, red maple, oaks, and white birch, with here and there clumps and scattered trees of the original species. Most of the wild land is thickly set with stumps, which is a factor in the cost or labor of preparing it for agricultural use.

A small amount of farming is being carried on on this soil which, on the whole, comprises potential agricultural land. The productiveness of the soil is greater than that of the deep sands of the Emmet and Roselawn series. Potatoes, timothy, and red clover, oats, rye, and corn (mainly for forage or silage), alfalfa, sweetclover, raspberries, and seed crops can be produced. Potatoes are the most dependable cash crop. Apples and other fruits for home use produce fairly well where favorable sites for the orchards are selected.

Location and the cost of clearing the land of stumps and stones have been factors preventing a more extensive agricultural development of this soil. Because of its sandy texture and low content of organic matter, it is not likely that the fertility of the soil will be very durable. Care must be taken to maintain or increase the organic-matter content by turning under green crops or applying manure. On slopes precaution must be taken against erosion. When the land is first brought under cultivation, stands of red clover, sweetclover, and alfalfa can be obtained without liming. Commercial fertilizers are not extensively used, but experience has shown that the soil responds to their use and that they can be profitably employed, particularly for potatoes, during years of average or high prices.

Emmet loamy sand.—Emmet loamy sand comprises most of the deeper sand soil of the hardwood hills. This soil under forest consists of the following layers: (1) A surface layer of mold and humus 2 or 3 inches thick; (2) a light-gray loose leached sand layer ranging from 6 to 10 inches in thickness; (3) a dark-brown or dull-yellow loamy sand layer from 6 to 15 inches thick; (4) a thin layer of pale-yellow sand grading into (5) the parent glacial sandy drift. In the cut-over land the layer of forest litter and mold originally present has been consumed by fires, and the surface soil consists of a 2- or 3-inch layer of loose sand mixed with sufficient humus and charred organic matter to produce color shades of gray or light brown. The cultivated soil is light-brown loamy sand consisting of a mixture of the first three layers of the virgin profile. Most of the sand is medium or fine in texture, and a few scattered cobbles and boulders occur in it.

The soil is low in fertility, as compared with the clay soils, but apparently it has a little higher content of available calcium and magnesium than sands of the pineland, such as Roselawn sand, and possibly it holds slightly more moisture, owing to the strong development of the brown subsurface layer, as compared with sands where this layer is absent or only weakly developed. In most places the soil reaction is acid, but in some areas it is nearly neutral or slightly alkaline in one or more layers.

The areas shown as Emmet loamy sand are fairly uniform, but in places some slightly more silty or clayey soil sufficient to make a sandy loam or loam, the same as or similar to Emmet sandy loam, may have been included, also some land that is moderately stony. The sandy soil with clay at a slight depth has proved to be the more productive. Gravelly areas are indicated on the soil map by gravel symbols.

The surface relief of the land, as seen from a distance, is that of a bold ridge or plateau of smooth, long, broad, sweeping slopes, but locally the land ranges from level to choppy and broken, and it contains short slopes which have a rise ranging from 15 to 25 feet in a hundred feet of horizontal distance. The land is dry and well drained, owing to the texture and structure of the soil and underlying drift and to the generally sloping surface. The water table in most of this soil lies at a great depth.

The land originally supported a fine forest consisting of a mixture of the common hardwoods—hard maple, beech, elm, yellow birch, and hemlock. On the larger bodies of this soil, it is probable that a much greater proportion of hemlock and white pine and a smaller proportion of ash, elm, and basswood grew than on Emmet sandy loam. With the exception of a few small remaining tracts, the trees have been cut for lumber, and most of the wild land consists of desolate burned-over slashing; old cut-over land covered with charred stumps, briers, grasses, and weeds; or land supporting a small scrubby growth of cherry, aspen, white birch, and small oaks. Only a very small part is well stocked for a new forest.

A few small farms have been developed on the smoother land, and rye, oats, timothy and red clover hay, potatoes, buckwheat, and sweet-clover have been grown. General agricultural conditions, absence of a large local population, distance to outside markets, and competition from other more suitable lands, both here and elsewhere, have prevented extensive development of this land for agriculture. The smoother land is given a rank of second class, and the steep slopes are ranked as third class, or submarginal, for general agricultural use. Many farms have been abandoned. The more open and less brushy land affords fair pasture for cattle and sheep.

Kalkaska loamy sand.—Kalkaska loamy sand includes the lighter and deeper sand soil of the dry sandy plains and valleys, which originally supported a hardwood forest. The chief visible difference from the sands of the pine plains is in the dark-brown or umber-colored layer which underlies the light-gray leached layer at a depth of a few inches. Beneath this layer, beginning at a depth ranging from 12 to 20 inches, is pale-yellow or gray loose penetrable comparatively dry sand which extends to a depth ranging from 8 to more than 10 feet. The soil is not highly fertile and is moderately

or strongly acid to a depth ranging from 30 to 40 inches. It apparently has a little higher average moisture content than the sands of the pine valleys and hence is a little more productive.

Kalkaska loamy sand is one of the less extensive soils. It occurs in valleys and on benches in association with the Emmet soils. The land is nearly level but is pitted here and there with shallow dry depressions.

The original forest cover consisted principally of hard maple, beech, yellow birch, hemlock, elm, and ironwood, together with a few scattered large white pine. The greater part has been cut over and has grown up to a second growth of maple, elm, and other species of the original forest, or, where more severely burned over, the growth is more largely aspen or the land is covered with grass. A small acreage has been cleared for farming.

Potatoes, oats, timothy and clover hay, alfalfa, sweetclover, beans, and buckwheat have been grown on this kind of soil in other counties with moderate success, but here the acreage is so small that it has practically no agricultural significance. With the exception of the more cobbly areas, the soil is easily plowed. Its chief deficiency is probably low moisture content. The sand has some tendency to blow in clean-cultivated fields, and, as on most of the sandy soils in this part of the State, fields are likely to be infested with quackgrass. Heavy manuring is essential, and it is probable that liming and the use of the commercial fertilizers would increase crop yields.

SOILS OF THE ROLLING CLAY LANDS

The largest bodies of clay land occur in the central part of the county a few miles north and south of Mio and east of Luzerne. The land is level or rolling. Compared with other soils, these soils are upland, but they do not rise so conspicuously above the sand plains as do the sandy hardwood lands and pine hill lands. The areas are composed mainly of low swells of clay and sandy land having sufficient natural drainage for agricultural use, but they also include numerous small shallow marshy or intermittent-pond depressions, and associated small bodies of flat wet and semiwet sandy, clay, and peat soils which are more characteristic of the wet swampy plains land.

The clay soils which characterize this kind of land are classified as Selkirk silt loam and Nester silt loam. Iosco sandy loam is described in connection with these heavier soils, because of its heavy substratum and its close geographic association with them. The small included bodies of the Bergland, Munuscong, and Ogemaw soils are described elsewhere in this report.

Selkirk silt loam.—Selkirk silt loam is characterized by a surface layer of dark-gray, ash-gray, and yellowish-gray silty loam or loam and by a comparatively impervious red clay layer which occurs at a depth ranging from 6 to 20 inches. The average moisture content is high, owing to the nearly level surface relief and the underlying plastic fine clay. In the older fields the thoroughly mixed cultivated surface soil is gray moderately heavy silt loam or fine sandy loam, which coheres strongly and clods if worked when wet. New land may have a variegated appearance of dark gray, light gray, yellow-

ish brown, or reddish brown, in conformity with variations in the texture, depth of tight clay, and microrelief.

The surface soil is in most places acid in reaction to a depth ranging from 6 to 12 inches, but the deeper grayish-brown or chocolate-colored underlying clay contains a high proportion of lime in the form of calcium carbonate. The soil is fertile, durable, and with proper drainage and tilth can be made productive. The subsoil is not so easily penetrated by plant roots as are the subsoils of the sands and other well-drained mineral soils, and under natural conditions the vegetation is comparatively shallow rooted. The land is dotted with ponds or marshy depressions filled with cattails and sedges. Much of the land is too wet and cold in the spring for the most successful farming, and it should be improved by artificial drainage.

The original forest growth consisted dominantly of hardwoods with an admixture of balsam fir and white spruce. Practically all the merchantable timber has been removed by lumbermen. The pine stumps remain, and the land has grown up in part to aspen and other second growth, but in part it is open, comparatively free from brush, and is used for grazing cattle and sheep.

The land seems to be naturally best adapted to dairying and grazing. Timothy and alsike clover hay is the principal crop. Other crops grown are oats, beans, peas, barley, and alfalfa. The brush-free stump pasture land supports an excellent growth of bluegrass, timothy, alsike clover, and redtop, in addition to native grasses and weeds. This soil offers some possibilities for further agricultural development.

Nester silt loam.—Nester silt loam comprises the better drained or more rolling clay land. Under a forest cover, or in the virgin state, the 2- to 4-inch surface layer consists of a mixture of forest litter, leaf mold, and humous soil. It is underlain by a gray or ash-colored silty and sandy layer from 3 to 6 inches thick. Beneath this is yellow or brown silty clay loam or sandy clay loam, from 3 to 8 inches thick, which is underlain by red or chocolate-brown moderately compact clay loam. This material is plastic when moist and when dry becomes pale reddish brown and is hard and crumbly. The substratum is clayey drift material, either massive red clay or alternate layers of clay and sand. Under cultivation the surface soil is a mixture of the upper three layers. It is grayish-brown light silt loam, loam, or sandy loam, which scours readily from the moldboard and is free from excessive cloddiness where care has been taken to prevent erosion.

The content of organic matter is not high but may be considered good for this section and is higher than that of the well-drained sandy soils. The proportionate quantities of clay, silt, and sand within plow depth differ considerably even in the same field, and there is also much variation in depth to the clay layer. The greater part of the soil is loamy in texture, and a heavy layer is present at a depth ranging from 15 to 24 inches.

In most places Nester silt loam shows slight or medium acidity to a depth ranging from 20 to 36 inches, but below this depth the reaction is alkaline, probably owing chiefly to the presence of carbonate of lime in the parent material. The soil is fairly retentive of moisture, owing to the clayey character of the subsoil and substratum, but it does not hold excessive quantities of water. Chemical analyses and other evidence show that the natural fertility is good. Nitrogen

and phosphorus are likely to be present in smaller quantities than are other plant nutrients, but there is no evidence that the quantities of these elements are abnormally small.

Nester silt loam is not extensive. The land is level or gently rolling, and, in general, natural drainage is adequate for successful farming. Serious erosion takes place on the steeper slopes when cleared.

The original forest cover consisted mainly of hardwoods, principally hard maple and beech, with smaller numbers of elm, basswood, yellow birch, and white ash. Some hemlock and a few scattered white pine were intermixed with the hardwoods.

On account of the small size of the individual areas and their close association with other soils, such as Selkirk silt loam, Ogemaw sandy loam, and Iosco sandy loam, few farms are composed entirely of this soil. The land is suited to the production of red clover and timothy hay, corn, oats, wheat, potatoes, navy beans, field peas, barley, rye, sweetclover, buckwheat, alfalfa, and rutabagas. Red clover returns good yields without liming or fertilization and is grown both for hay and as a seed crop. Alfalfa can probably be grown with moderate success. Apples are the principal orchard fruit.

This soil is practically free from large stones and presents no special tillage problems. Commercial fertilizers, if applied, would probably profitably increase the yields of grain, potatoes, and beans. It is most essential to maintain the supply of organic matter through the use of barnyard manure or by turning under green-manure crops.

Iosco sandy loam.—Iosco sandy loam consists of a layer of fine sand and medium sand, ranging from 2 to 4 feet in thickness, underlain by heavy and impervious clay. The profile of this soil shows the following layers: (1) A 1- to 3-inch layer of gray humous material; (2) a lighter gray leached sandy soil, from 4 to 12 inches thick; (3) a layer of yellowish-brown, rust-brown, or coffee-colored sand which is loamy but cemented in places, from 6 to 12 inches thick; (4) a leached gray or mottled wet sand or sandy loam subsoil ranging from 2 to 20 inches in thickness, underlain by a substratum of pale reddish-brown or chocolate-colored clay. In plowed fields the surface soil, a mixture of the upper three layers, is grayish brown or light brown, and it contains sufficient organic matter and fine particles of mineral matter to produce a loamy texture. Most of the land is practically free of stones or cobbles.

The depth to the clay substratum, as well as the color and coherence of the sand vary considerably. Some deep sand, similar to Roselawn sand and Emmet loamy sand, and a few spots of heavier soil like Selkirk silt loam are included.

This soil is low in organic matter, rather strongly acid in the sandy layers, alkaline in the clay substratum, and has low natural fertility. The sandy subsoil in most places is moist and in many places is water-logged just above the clay substratum.

The surface relief is slightly undulating, or billowy, and the land is marked by hummocks or low ridges of sand with intervening swales or pocketlike depressions. The elevated areas are dry, but in the pockets and other low places the soil is soggy or water-logged.

The original forest growth consisted mainly of white pine and red pine, together with hemlock and some hard maple, beech, and other hardwoods on the more clayey areas. Where the brush has been kept down by fires or by cutting, the land affords fair pasturage for sheep and cattle. Bluegrass is abundant, and timothy and alsike clover grow wild in places.

A very small proportion of this land has been cleared for farming. Potatoes, rye, buckwheat, corn, oats, beans, timothy, and red clover are grown, and in a few places fairly satisfactory yields are obtained. The growth is likely to be spotted and variable on large fields, because of differences in the moisture supply and in the depth of the sand. With proper management this soil has some agricultural value, especially for potatoes, but it is regarded as inferior to the Nester and Selkirk soils for hay and grain.

MINERAL SOILS OF THE WET LANDS

Wet sandy soils occupy narrow strips on the borders of peat swamps and lakes and larger areas on flat plains of the upland and river terraces, where the water table is held up by underlying clay. There is a wide range in drainage conditions, and some of the land included is nearly as permanently wet as the peat swamps, whereas in other situations where there is a wide fluctuation in the depth to the water table, the surface may become dry and evidence of permanent water-logging may appear only at a depth ranging from 2 to 3 feet. In these latter situations peculiar rust-colored and coffee-brown layers of sand, or sandy hardpan, develop at a slight depth. The soils have a somewhat black mucky or peaty layer on the surface, and this is directly underlain by a gray or white bleached layer.

The deeper sandy soil has but little agricultural value, as the natural fertility, durability, and the size of the separate bodies are not sufficient to justify the high cost of reclamation, which would involve ditching and tiling. The labor and cost of the removal of a dense cover of vegetation and stumps also restricts the use of this land. Under natural conditions a dense cover of plant growth is sustained, owing to a combination of abundant moisture and a thick surface layer of mucky or humous soil.

Wet land directly underlain by clay is represented in small bodies. Such land in general supported a higher percentage of hardwoods and a larger volume of growth in the original forest. It affords fair pasture, and offers greater possibilities for agricultural use than the deep wet sands.

Newton sand.—Newton sand comprises the soil of the wetter sandy swamps, where the water table is but slightly lower than that of the peat swamps. It is characterized by a thin mucky or peaty covering, ranging from 2 to 6 inches in thickness, over gray water-soaked sand which, in most places, shows smoke-colored stains or rust-yellow splotching at different depths. In most places the sand is of medium texture and extends to a depth of more than 3 feet. The water table lies at an average depth between 12 and 15 inches, but at times it is practically at the surface.

This soil is widely distributed, but most of it occurs in small bodies as narrow strips bordering swamps and lakes. Some of the

soil included in mapping is little else than shallow peat of the Rifle or Greenwood type, and in other places it grades into Saugatuck sand.

Newton sand is strongly acid and since, aside from the organic surface layer, it is merely leached water-logged sand, the fertility is low. Under natural conditions the principal source of fertility lies in the organic surface soil.

The land is not used for cultivated crops and under present economic conditions has practically no agricultural value, except possibly (under certain conditions) for pasture. Most of it is characterized by a dense thicketlike growth of aspen, alder, willow, white birch, black spruce, cedar, and tamarack, together with blueberries and shrubs common to peat and muck soils. Originally it supported considerable white pine. Trees are very shallow rooted on account of the high water table.

Saugatuck sand.—Saugatuck sand comprises the wet sandy soils characterized by a rust-colored or brownish-black hardpan sand layer at a slight depth. The water table fluctuates from a depth of a few inches to 3 feet below the surface, and the sand in most places is 3 feet or more thick. The land is in general flat and lies from only 1 to 5 feet above the adjacent swamp or water surface, although the surface relief in most places on old cut-over land is uneven, owing to a "pit-and-mound" microrelief. Although the hardpan sand and water-logged condition are characteristic, they are not everywhere present in the areas mapped, as slight differences of a foot or two in elevation and slight variations in depth to clay cause either a wetter or drier condition and a change in soil. Areas of Newton, Ogemaw, Munuscong, Rubicon, and peat soils are intimately associated with this soil in many places.

Saugatuck sand is strongly acid, and its fertility and productivity are low when the land is placed under cultivation. Under natural conditions it supported a fairly heavy volume of vegetation. Large white pine and hemlock grew on the higher land and a mixture of balsam, cedar, spruce, aspen, red maple, elm, birch, and ash on the associated wetter soil.

The land has very little agricultural value, but, as it supports a large amount of wild vegetation, it has considerable value for forestry, game refuges, and pasture. Christmas trees, posts, pulpwood, blueberries, wintergreen, and ferns are natural products of some value.

Ogemaw sandy loam.—Ogemaw sandy loam is characterized by a dark-colored surface soil, by a yellow or coffee-brown sandy subsoil, in places cemented, and by the presence of clay at a depth ranging from 24 to 40 inches. The basal part of the sandy soil is more or less permanently wet, or water-logged. The surface soil in most places is acid, although in a few places it may be nearly neutral or slightly alkaline; the sandy subsoil is strongly acid; and the clay substratum, owing to the presence of lime or calcium carbonate, is alkaline.

This soil occurs as small patches of nearly level land, but locally the surface relief may be very uneven, owing to small mounds and pits caused by the uprooting of trees. The higher average moisture content is shown in the darker color and greater accumulation of

organic matter, as compared with the drier sandy soils, such as Rubicon sand, and the present vegetal cover and the composition and character of the original cover also indicate greater fertility than in Saugatuck sand.

The original tree growth consisted mainly of white pine which in places must have attained very large size, judging from stumps. There was a mixture of hemlock and the hardwoods, such as elm, ash, and basswood, together with more or less spruce, fir, and arborvitae. The land has been completely cut over by lumbermen. The present cover of the wild land consists of a dense brushy growth of aspen, alder, willow, and briers, with scattered clumps or individuals of the hardwoods and other original species.

Small patches here and there are farmed, but the greater part remains as wild land or stump pasture. The land is easily plowed and tilled when cleared of stumps and roots and leveled. Potatoes, corn, oats, rye, timothy and clover hay, and other crops have been grown with fair results on this soil in other counties. Plant growth is not uniform, however, owing to variations in the moisture conditions and the content of organic matter. The cut-over land is for the most part thickly set with stumps, and the cost of clearing and leveling is high. Where the brushy second growth has been kept down by fire or other means, the land affords good grazing for cattle and sheep.

Bergland clay loam.—Bergland clay loam includes the heavier mineral soils developed under poor drainage. It occurs as swampy land in swales, on slopes where there are seepage springs, and on the borders of peat and muck swamps. The surface soil to plow depth is dark gray or nearly black, owing to the high content of organic matter, and the texture is loam or clay loam. Underlying this is a gray or drab plastic clayey layer which, in turn, is underlain by bluish-gray or gray and yellow clay showing the physical and chemical characteristics common to clay of the glacial drift of this section. The soil seems to be fertile, and it is alkaline or nearly neutral in reaction. Very little of it has been used for agriculture, however, because of its occurrence in small bodies and the excessive cost of clearing and draining. Native grasses, alsike clover, and timothy afford good pasture where the land has been cleared of trees and brush.

Munuscong sandy loam.—Munuscong sandy loam is a dark-colored wet sandy soil underlain at a depth ranging from 12 to 30 inches, by clay similar to that underlying the Bergland soils. The content of organic matter is high, the reaction slightly acid or alkaline, and the natural fertility medium or high and fairly durable under cultivation.

This soil occurs in low-lying, swampy situations and was originally occupied by a dense forest of cedar, fir, spruce, elm, soft maple, balm-of-Gilead poplar, aspen, and some white pine. The second growth consists of alder, willow, aspen, and other species of trees which grew in the original forest, and there are some open marshy areas. The agricultural value of the land is slight, because of the difficulty of clearing and draining and the small size of the separate bodies. Under cultivation, however, this soil is capable of producing fair yields of hay and small grains, and where cleared of brush it furnishes good wild pasturage.

Granby gravelly sand.—Granby gravelly sand includes soils with black or dark-brown surface material of more or less thoroughly decomposed organic matter containing sand and gravel, underlain at a depth ranging from 3 to 10 inches by gray or dingy-white wet sand which in most places is neutral or alkaline in reaction. In most of the areas mapped the soil is gravelly either at the surface or at a slight depth.

The surface layer varies in thickness and is not uniform over any large area. In places, on the slightly higher ridges, it is dark-gray loamy sand or fine sandy loam underlain by loose gray sand. The content of organic matter in these areas is low in comparison to that in wetter areas. The texture of the subsoil varies, also, and different borings show a range from fine sand to coarse sand and gravel. In some included depressions muck is underlain by gray sand at a depth of only 12 or 15 inches.

Only a very small total area of Granby gravelly sand is mapped. Where the location is favorable and the land adequately drained, it has a fair value for general-farm crops and, where cleared of trees and brush, some value for pasture.

Griffin sandy loam.—For the most part the streams of the county flow through peat swamps, but the lower courses of some of the larger ones are bordered by comparatively narrow strips of wet or semiswampy bottom land composed of alluvium carried by the streams and deposited during occasional overflows. Most of the alluvium is not thick, and, where it consists of dark-gray and yellow or rust-colored sand and sandy loam, it is mapped as Griffin sandy loam. The water table is high, and the soil contains a large proportion of organic matter, in fact, it is an alluvial muck in places. It is comparatively fertile, but, because of poor drainage and narrowness of the bottoms, it has practically no agricultural value.

The bottoms originally supported a dense growth of mixed hardwood and coniferous trees, together with a dense shrubby undergrowth. Elm, ash, red maple, balm-of-Gilead poplar, and aspen were dominant species, with some cedar, white spruce, black spruce, fir, tamarack, alder, and willow.

Griffin loam.—Griffin loam includes those areas of mineral stream-bottom lands in which the soil is generally heavier than sandy loam. The texture ranges from clay loam to loam. The soil is otherwise similar to Griffin sandy loam and occupies the wet, or semiswampy, lands bordering the streams. It is subject to overflow during floods. In character of native vegetation and agricultural possibilities, Griffin loam is similar to Griffin sandy loam. It would, if cleared and sufficiently drained, support good pasturage and hay crops.

ORGANIC SOILS

The organic soils are composed dominantly of plant matter and in this respect constitute a distinct class, compared with the soils composed of mineral or inorganic matter. In this county the organic soils occur in swamps, heath bogs, and marshes. The deposits have accumulated in such permanently wet situations as the following: (1) Irregular-shaped flat areas, where underdrainage is obstructed, and in stream valleys; (2) on slopes permanently wet from seepage

springs; and (3) in certain types of lakes. The deposits composing the organic soil, or from which the soils have been derived, range in thickness from 1 foot to as much as 40 feet; differ in the character of the mineral substratum—whether marl or clay; differ in the average depth of the water table; and also differ in age, stage of decomposition of the plant matter, ash content, and amount of admixture of foreign mineral matter. These soils comprise 6.5 percent of the total area of the county. Their agricultural value is low, and there seems to be little probability of any extensive use of the areas, because of their location and the adverse climatic and economic factors to be overcome. On account of the great amount of time and labor involved and the small economic justification, no attempt has been made to map more than a few of the possible subdivisions of the organic soils. Fairly well defined types or groups are recognized, although the differentiation is not so consistent as for the mineral soils. The less decomposed and coarser organic soils are differentiated as peat and the more decomposed as muck.

Rifle peat.—Rifle peat is brown or dark-brown, coarse, woody, or loamy material, very high in organic matter (75 percent or more), which is underlain at a depth ranging from 6 to 20 inches by either a fibrous or a coarser textured, woody mass of plant matter showing very little decomposition. The average depth of the water table probably ranges between 10 and 20 inches. This peat ranges from acid to nearly neutral in reaction. The mineral substratum in most areas is sand.

The vegetation consists of a dense growth of arborvitae (white cedar), black spruce, balsam fir, and tamarack, with an occasional hemlock and white pine. Where the swamp land has been logged off and burned over it has grown up in places to dense thickets of aspen, alder, willow, and white birch, and treeless open areas support a heavy cover of sedge (such as *Carex filiformis*) and bluejoint. In places, vegetation of the more acid-bog type (Greenwood peat), such as leatherleaf, Labrador-tea, blueberry, and laurel, occurs in association with the tree growth.

The land has little or no agricultural worth and its value, for the present at least, consists chiefly in the tree growth, which it is capable of producing, and as game refuges. Sedges and grass are cut for hay from a few areas.

Rifle peat occupies the largest acreage (77.1 percent) of the muck and peat land. It is widely distributed both in the stream-valley and the lake-filled swamps.

Lupton muck.—Lupton muck is black or brown granular loamy muck high in organic matter, comparatively high in ash content, comparatively fine in texture, and showing such evidence of marked physical change and decomposition of the parent plant matter at the surface that botanical identification of the plants is difficult or impossible. This material is 10 or 12 inches thick and, in some places, extends to a depth ranging from 2 to 3 feet before the usual yellow or brown coarser, more fibrous, and less decomposed peaty material is reached. This muck is for the most part nearly neutral or but slightly acid in reaction. The water table under natural conditions in swamps probably lies at a depth between 18 and 30 inches.

The vegetation now includes, or originally included, a large proportion of elm, black ash, aspen, and soft or red maple, in association with the characteristic coniferous species of the swamps of this section, such as cedar, spruce, fir, and tamarack, a small amount of hemlock and white pine, and an occasional basswood.

This type of muck occupies only a small acreage and is not widely distributed. It occurs in the valleys of the larger streams and in small basins of glacial origin. In a few places it is underlain by marl, but in most places the substratum is sand or clay. The land has practically no agricultural value, although a similar type of muck has been used with some success for special crops, pasture, and a few of the general-farm crops in the southern part of the State, where climatic conditions are more favorable. It produces fair pasturage when cleared and is capable of producing a thriftier tree growth than other types of organic soil.

Greenwood peat.—Greenwood peat is fibrous or coarse-textured, loose or uncompacted, brown or yellow material which shows very little decomposition of the plant matter even in the surface layer. It is uniformly very strongly acid in reaction. The water table is at or within a few inches of the surface, although in very dry periods it may sink to a depth ranging from 1 to 2 feet. Deposits accumulated in deep lakes are commonly underlain by water or soft soupy peat and would be subject to great shrinkage in thickness if the land were drained. Land of this kind is characterized by open heath bogs of leatherleaf (*Cassandra*), Labrador-tea, blueberry, laurel, cranberry, cotton grass, and sphagnum moss. In places there is a small, dwarfed growth of tamarack and black spruce, also a few red pines and jack pines. Some of the more open land is marsh or meadow, covered chiefly with sedges.

This highly acid soil occurs in widely distributed small bodies representing the sites of small lakes which have been filled in by the accumulated remains of vegetation, and it also occurs in larger bodies as recent accumulations on poorly drained sandy flats. The land has no agricultural value except the remote possibility of its use for growing such crops as blueberries and cranberries. The sphagnum moss and blueberries, which the bogs yield under natural conditions, may have some present or possible future value. The tree growth is of practically no value.

Kerston muck.—Kerston muck occurs in the swampy bottom land of Au Sable River and its main branches. It is a dark-colored muck or peat, similar to Lupton muck and Rifle peat, but it contains considerable alluvial material—sand or silt—either mixed through the plant matter or in separate layers. Areas of this material grade into Griffin sandy loam or are so dominantly organic that they are not materially different from the Lupton, Rifle, and Houghton types of organic soils. Most of the land lies from 1 to 3 feet above the level of the streams, and it is forested with spruce, cedar, tamarack, alder, willow, aspen, white birch, elm, ash, and red maple. The land has little agricultural value.

Houghton muck.—Houghton muck consists of dark-brown or black finely fibrous plant remains. This material is loose, or not compact, ranges from nearly neutral to medium acid, and contains very little admixed mineral matter. The underlying material may

be black, fine in texture, and pasty or cheeselike. The water table under natural conditions is very near the surface. The plant matter contained in Houghton muck is somewhat less loamy and less decomposed at the surface than in Lupton muck, and it is less strongly acid, darker in color, and finer in texture than in Greenwood peat, but some peat is included which shows no difference from Greenwood peat, other than the absence of woody matter and roots of shrub vegetation.

Houghton muck occurs in only a few small, scattered bodies. The native marsh vegetation consists dominantly of a sedge (*Carex filiformis*), bluejoint, and in places a few stunted alder, willow, and aspen bushes. The land has no agricultural value but may have some value as breeding and feeding grounds for aquatic animals.

SOILS AND THEIR INTERPRETATION

The morphology, classification, and genesis of the soils of Oscoda County are discussed briefly in the following pages.

The two major classes of soils, ordinarily designated mineral soils and organic soils, represent the greater part of the area. The mineral soils comprise about 93 percent of the total area and the organic soils about 5 percent. Lakes and very wet marshes comprise scarcely more than 1 or 1.5 percent of the county, and soils which are essentially exposures of geologic formations, are also negligible in total area.

The mineral soils consist of two major taxonomic divisions, based on the average amount of water in the solum, as follows: (1) A division containing normal moisture for the region, which is equivalent to a division of naturally well drained soils; and (2) a division in which free water exists permanently, or for considerable periods, to the point of complete soil saturation and water-logging. The first division is estimated as occupying about 95 percent of the total mineral soil area, and the second about 5 percent.

The group of well-drained mineral soils having completely developed profiles are podzolic, but well-developed Podzols cover only a small part of the county. The older soils are all podzolic, in that leaching and the translocation of sesquioxides and particularly the removal from the solum of calcium and magnesium carbonates are dominant in the soil-forming processes. Some of the soils are transitional in character, for example, Roselawn sand, but none is exactly comparable to the Gray-Brown Podzolic soils of the more southerly part of Michigan.

The generalized profile for the virgin soil of normal moisture content and of mature soil profile in northern Michigan is as follows: (1) An accumulation of litter and peaty forest mold, or F layer; (2) a very thin humous soil layer; (3) a highly leached gray layer; (4) a layer of brown or yellow humic and iron oxide coloring; (5) a layer of maximum clay content; and (6) the parent material, or geologic substratum.

This group is represented by the following three subgroups, differentiated on the basis of the texture and consistence in the successive layers in the soil profile: (1) A subgroup, in which the soils are underlain by clay which is comparatively dense and impervious in

layers 4, 5, and 6 of the generalized profile described; (2) a subgroup, in which the soils are underlain by sand and gravel or comparatively loose and pervious material in layers 4, 5, and 6; and (3) a subgroup, in which the soils have more clay-colloid material in layers 4 or 5, whereas layer 6 is less clayey and more pervious. The subgroups are still further differentiated into soil series and types, on the bases of differences in color, texture, structure, chemical characteristics, and thickness of the various layers.

Layer 3, representing maximum eluviation, and layer 4, maximum humic coloring, are the outstanding features of the complete profile. It seems that these layers reach their maximum development in thickness, intensity of brown or yellow color, and removal of inorganic colloids in areas where the parent material is sandy and under conditions of moderately high average moisture; whereas, at the other extreme, the minimum development occurs where the parent material is either comparatively impervious clay or very dry sand and gravel. The normal thickness of layer 3, the gray highly eluviated layer, ranges from 4 to 8 inches, but under exceptional conditions it may range from 18 to 24 inches. The thickness of the brown, or humic, layer 4 is commonly from 6 to 12 inches, and the maximum thickness is between 30 and 40 inches, although the base of this layer is not sharply marked, especially where the parent material is loose sand. Under certain conditions, layers 4 and 5 coalesce as a single layer, and the maximum intensity of humic coloring is ordinarily at the top of the layer. Field observations indicate that the darkest brown or umber color occurs where the sand or gravel contains the largest amount of calcium carbonate or magnesium carbonate, although it is apparent that a certain moisture condition is the dominant or controlling factor. The maximum content of iron oxide and maximum cementation in this layer appear to exist in such soils as Saugatuck sand, where saturation is frequent and the water table high, but where there is also a wide range, or fluctuation, in the content of water throughout the year.

The thickness of forest surficial litter and mold (or F layer) under an old or mature unburned virgin forest and under conditions of good drainage, is normally 2 or 3 inches in this region. The thickness increases as the moisture conditions approach those of swamp, whereas at the other extreme there is less than 1 inch of fluffy organic matter from grass, lichen, and moss on Grayling sand and Grayling loamy coarse sand on the open driest sand plains. True humous soil, such as occurs in the subhumid Prairie soil region of the United States and in the Gray-Brown Podzolic soils region of the central and eastern parts, is absent or is developed only as an extremely thin layer. The greatest amount of humus (highly decomposed or completely altered organic matter) is present, other conditions being the same or similar, where the parent material is most limy or basic and the moisture comparatively high but not wet to the point of saturation.

Layer 5 is weakly developed and shows no evidence either of marked clay concentration or of intense coloring by ferric oxides developed in the soil-forming processes. A layer containing a higher proportion of clay or colloids than the parent material is less evident than in the central and southern parts of the United States.

The development of such a layer in northern Michigan is most noticeable in coarse gravelly calcareous material. Only slight intensification of ferric oxide coloring over that of the parent material occurs in the purer clay.

A certain type of profile which may be regarded as representing a relatively mature soil, not uncommon in the northern part of the State, is characterized by a separate horizon lying between the brown, or orterde, horizon and a lower B or C horizon. This horizon in places has a gray color, is harsh to the sense of touch, and in appearance suggests that iron and colloids have been removed in the soil-forming processes, although this has not been convincingly confirmed by chemical analyses. This horizon occurs in well-drained land and therefore is not to be attributed to a water-logged condition. It appears to be developed best where the parent material is very sandy clay. Complete chemical analyses of four horizons of a profile of Emmet sandy loam, which shows a gray horizon below the brown, or orterde, horizon, is presented in table 6.

TABLE 6.—*Chemical analysis of Emmet sandy loam in sec. 21, T. 28 N., R. 3 E., Oscoda County, Mich.*[1]

Horizon	Depth	SiO_2	CaO	MgO	SO_3	Na_2O	K_2O	H_2O	CO_2	Fe_2O_3	Al_2O_3	Mn_3O_4	TiO_2	P_2O_5
	Inches	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Gray layer	1–4	91.21	0.40	0.34	0.10	0.89	0.91	0.29	1.90	1.16	2.83	0.02	0.21	0.01
Brown layer	4–10	83.40	.85	.72	.35	1.00	1.48	.64	.80	2.93	8.56	.03	.35	.11
Gray layer	10–30	89.70	.67	.45	.09	1.06	1.11	.21	1.75	1.76	3.97	.03	.24	.03
Lower subsoil layer	30–48	86.18	.78	.42	.16	.83	1.07	.60	1.71	1.86	5.71	.03	.31	.09

[1] Analysis made by O. B. Winter, Michigan Agricultural Experiment Station.

The depth to which carbonates have been removed from the soil in the soil-forming processes is, in general, from 30 to 48 inches, but it varies, of course, according to the amount of carbonates originally present, the texture of the parent material, the surface configuration, and the age of the soil. In dense clays complete removal has taken place to a depth ranging from 18 to 30 inches, whereas in some sands removal appears to have been complete to a depth ranging from 5 to 6 feet. In some other soils, where the parent material consists predominantly of sand, gravel, cobbles, and boulders, some limestone rock may remain throughout the profile, although such soil is scarcely represented in this county. Phosphorus and potash are also removed in the soil-forming processes, especially in layer 3. Nitrogen is highest in the surface layer of organic accumulation and is also present in appreciable quantities in layer 4. Where the parent material is friable sandy clay drift and a compact layer 5 is developed, a second layer of leaching and of pale or light-gray color between layers 4 and 5 is present. In most places the thickness of the solum ranges from 30 to 40 inches, and so far as this is indicated by alteration or development of color due to weathering, it appears to be no thicker in the loose, driest sands than in the densest, most impervious clays.

The older mineral soils developed under poor drainage or excessive moisture show the following generalized profile: (1) A dark-gray or black surface layer consisting, in part, of accumulated organic matter; (2) a gray or drab layer, not colored or but slightly colored by organic matter; (3) a layer containing a maximum amount of clay and having a maximum degree of coherence or plasticity, or one containing maximum yellow or brown coloration and cementation from iron oxides; and (4) the substratum, or parent material. Leaching is greatest in layer 2, and this layer reaches its greatest thickness where the parent material is sand. These soils are also leached of carbonates but apparently not to so great a depth as the well-drained soils, and most of them are higher in fertility, measured by the total amount of nitrogen, calcium, phosphorus, and potash, given the same parent material. Where the parent material is calcic or basic, the soils commonly show an alkaline or neutral reaction from the surface downward. Where the parent material is sand, layer 3 commonly shows a marked or even solid yellow or brown color from humic matter and iron compounds and may be more or less cemented into a hardpan.

The younger mineral soils, showing the least or most incomplete profile development, are represented in this county mainly by recent alluvium in the valleys of the streams. Most of this material has a high average moisture content or occurs as swampy or semiswampy land. The alluvium is entirely local in origin and commonly contains a high proportion of organic matter sufficient to mask the mineral color at the surface. In many places the deposits consist of alternate layers of mineral alluvium and muck, in which the muck or peat is partly transported but mainly accumulated in place. Very recent colluvial sandy wash in dry valleys and basins, blow sands, and beach deposits along lake shores occur, but they are of very small extent and have not been indicated on the soil map. Soils having incomplete profiles, owing to erosion under natural conditions, also occur but are almost negligible in total acreage.

The group of organic soils is represented by a number of types which range considerably in chemical and physical properties. Both young and old soils are represented although none of the soils appears to have developed such complete alteration or alteration to so great a depth as in the southern part of Michigan. Practically all are high in organic matter; that is, they contain 75 percent or more of material combustible on ignition. The greater number of deposits appear to have been accumulated in valleys or on permanently wet flats rather than in lakes, although the lake-filled deposits are also represented. The deposits, in general, do not reach a great thickness but in most places are more than 3 feet thick. On the sites of lakes they are, in places, from 20 to 30 feet thick or even thicker. Most of the thin deposits are underlain directly by sand, and deposits underlain by marl and clay are much less common than in other parts of the State. The deeper lake-filled materials present the common sectional characteristics, that is, they consist of pasty or gelatinous green or gray material at the base and a succession of layers differing in texture and composition according to the stages in plant succession, which range from aquatic plants to forest trees.

Complete alteration, represented by an almost black or dark-brown color and complete destruction of the botanical character of the plant remains, is not common and in most of the oldest deposits does not exceed 10 or 12 inches. In the most acid peat type (Greenwood peat), practically no alteration has taken place, although there is a much greater range in fluctuation of the water table than in the more woody and less acid types, such as Lupton muck and Rifle peat. A small part of the Greenwood peat is nearly neutral in reaction and comparatively high in lime, but the greater part ranges from moderately acid to very strongly acid. In general, the most acid organic soils are associated with the sands and the least calcareous phases of the glacial deposits, but in a number of places the acidity seems to be dependent on the height of the water table and on the rawness or lack of decomposition of the plant matter, as the adjacent soils and drift may be limy and the drainage waters alkaline. The characteristics of organic soils, like the characteristics of mineral soils, are probably determined by the growing vegetation and the climate, modified to greater or less extent by the influence of the geologic formations and the physiography of the region in which they occur. Thus, it seems probable that the oldest organic soils in this region cannot reach so complete a state of decomposition as organic soils in regions farther south, and that the texture and consistence of the organic soils differ because of the differences in temperature and in the plant species composing the parent material.

In the classification and mapping of soils the lakes and water-covered surfaces are largely of academic interest at present but, nevertheless, justify some consideration as an economic factor, as they support vegetation which has a food or protective value for fishes, aquatic birds, and mammals, and in addition they have some possibilities for the production of feed for farm animals and for the production of certain plants otherwise useful to man. Thus considered the lakes, with their bottoms, may be conceived of as consisting of three master layer as follows: (1) The surface layer, the aqueous or liquid member; (2) the cumulose or sedimentary intermediate member consisting, for example, of an ooze or a soft gelatinous mobile mass of animal sedimentation or precipitation; and (3) the old geologic or basal substratum. The waters thus can be subdivided most logically on the basis of physical and chemical differences which theoretically have a determining influence on the kind and character of plant growth. The chemical composition of the water, particularly whether acid, alkaline, or saline; the thickness or depth of the water covering; the chemical character of the material in the second and third layers, considered as to fertility; and their lithologic character and texture, whether marl, peat, sand, clay, or hard rock, serve as bases for subdivisions, to whatever degree it may be practical to carry a classification. No attempt has been made in this survey to classify and show the distribution of the different types of lake materials on the map, although some facts of an observational nature can be stated.

The lake waters are generally clear or free of mineral matter in suspension and are generally alkaline in reaction, owing very probably to the presence of calcium and magnesium bicarbonates; sand and peat bottoms are most common; marl occurs in only a few

places and is not so widely distributed as in the central-southern part of the State; and hard-rock bottoms seem to be entirely absent. Levels of the larger lakes are fairly constant or subject to no great fluctuation. In most of the bogs, largely occupied by such plants as leatherleaf (*Cassandra*), blueberry, and sphagnum moss, the standing water is acid in reaction and the coarsely fibrous or stringy underlying peat is highly acid. The stream waters are predominantly alkaline in reaction and are clear, that is, they are generally free from suspended mineral sediment, but where issuing from or flowing through peat swamps, they commonly have a brown or straw-colored tint caused by suspended or dissolved organic matter. The bottoms of most of the stream channels are sand or peat. The streams have a moderately rapid flow after leaving their sources in swamps and lakes and in general are not subject to rapid rises or fluctuations in level.

Common hydrophytic plants in the lakes are: White and yellow pond lilies, pondweed (*Potamogeton*), bladderwort, chara or musk grass, water milfoil, arrowhead, bogbean (buckbean), lake bulrush (*Scirpus*), cattails, and sedges (species of *Carex*).

All the soils differentiated here occur in gradational series, according to differences in the moisture or drainage conditions under which they have developed. This gradational character of soil types is universal, and under such conditions the limits established for each soil must necessarily be somewhat arbitrary, and each type must include soil of a transitional character.

In northern Michigan a more or less complete moisture series can be recognized for each of the following classes or groups of parent material: (1) Moderately pervious stony and sandy friable clayey drift; (2) loose incoherent sand; (3) massive fine-grained compact clay; (4) sand over impervious clay; (5) pervious unconsolidated sand, gravel, and cobbles; and (6) organic materials. The degree to which alteration of the parent material has taken place under the different moisture ranges possible is determined by the climatic conditions and the period of time during which soil-making processes have operated. Each of the parent-material groups listed covers a fairly wide range of moisture conditions and a corresponding range or gradation in chemical and physical differences, which constitute the basis of differentiation of the soils into types. For example, given parent material of sand, conditions may range from swamp, in which the sand is covered with muck or peat and bleached or mottled beneath (Newton sand), to the driest condition, where the mold and humus are extremely thin and dry and where there is little or no development of gray and brown layers or leaching of iron oxide color (Grayling sand).

A knowledge of the lithologic character and of the topographic forms of the glacial deposits becomes important in the explanation of facts concerning the chemical and physical character of the soils and their geographic distribution and for speculation on their evolution. In this county there is the usual admixture of detritus from rocks of the northern part of Michigan and Canada and the usual heterogeneity in rock composition but perhaps less rock from purely local sources than in other parts of the State where the drift cover is much thinner. Here the covering of unconsolidated deposits over

the old Paleozoic formations is probably from 100 to 400 feet thick.[4] Although the coarse drift appears to contain less limestone in this county than in counties to the north, there is an appreciable influence from this kind of rock, together with a small amount of shale from the Devonian and Silurian formations to the north. This influence appears to be strongest in the northern part of the county and decreases southward. The glacial clays, which comprise only a small proportion of the parent soil material, are calcareous but show only a faint red color. The more arenaceous or coarser textured drift is gray or faint reddish gray, apparently is derived mainly from land regions to the northeastward in Canada, and covers a much greater area than the clayey drift. Consequently there is less evidence of vivid, or hematitic, red color in the soil profile than in some other parts of northern Michigan and a great predominance of sand and sandy loam soils over loam and clay soils.

The diversity of soils, their intimate association in many places in small bodies, and the textural gradation of one soil into another are traceable to the lithologic heterogeneity and range in texture of the parent soil material, to the variations in thickness of relatively pervious material over relatively impervious material, resulting in a wide range in moisture conditions. There is also a diversity in the surface configuration of the Pleistocene formations, such as moraines, outwash plains, till plains, old lake beds, and old glacial drainage valleys.

The formations were laid down during the last stages of the glacial period (the Wisconsin), and the land surface is comparatively young. The surface configuration is almost entirely constructional, as streams have not yet had time to develop complete dendritic systems. Therefore large areas remain flat and wet, and mineral soils have developed under conditions of excessive moisture, together with the accumulation of peat deposits. On the other hand, soils developed under conditions of low moisture have been possible because of the perviousness and great thickness of some of the glacial deposits, notwithstanding the surface may be level. This is particularly true of the outwash plains. Various wet and dry conditions and differences in soil types on the moraines are the result of differences in the texture and composition of the glacial debris, rather than the result of stream erosion or slope of the land surface. The change from Emmet soils to Roselawn soils on the same moraine, without change in relief, may be accounted for by a corresponding change in the amount of limestone and clayey matter in the drift. Generally, the more gravelly and cobbly drift, both in moraines and outwash plains, produces the more loamy soil.

The native vegetation, as is universally true, has been a great factor in the development of soil characteristics; but, as is also generally true, the vegetation is both a cause and an effect of soil differences. In this county the whole area, with the exception of the very small acreage of lake surface, marsh, and peat bog, was originally forested. Most of the forest cover was dense, even junglelike in

[4] LANE, A. C. MAP SHOWING GEOLOGICAL FORMATIONS AND CONTOURS OF ROCK SURFACE OF THE SOUTHERN PENINSULA OF MICHIGAN. REVISED FROM STATE REPORTS AND UNPUBLISHED DATA. *In* Leverett, F., and others. Flowing Wells and Municipal Water Supplies in the Middle and Northern Portions of the Southern Peninsula of Michigan. U. S. Geol. Survey Water-Supply Paper 183, map between pp. 8 and 9. 1907.

some of the wetter situations, but in some of the drier areas, as on Grayling sand, the growth was comparatively open and consisted of pines, with a shrub and herbaceous undergrowth. The woody character of the surface accumulation of organic matter and the thickness of the humous soil and of the underlying gray and brown layers, if not wholly, at least in part, are attributable to the forest vegetation. Any constant relationship of thickness or intensity of coloring of the several layers to a particular type of forest vegetation is not apparent, but the texture of the soil material and the average moisture content seem to be the dominant controlling factors. Equally strong or equally weak development of the various layers occur under all the different types of forest, other than the swamp and the dry pineland types. The composition, texture, and other physical properties of the organic soils are clearly related to the kind of vegetation growing on them; and on the dry sand soils, such as Rubicon, Grayling, and Roselawn sands, the grasses and other herbaceous vegetation, together with mosses and shrubs, such as blueberry and sweetfern, have had an influence in determining a soil profile different from that of other soils. Influence from types of vegetation which preceded the present may be assumed, although too little is known about the plant succession and histology, as shown in the soil profile, to venture a statement of the specific character of such influence, except in the peat deposits.

Analyses of five surface soil layers with the accumulated organic matter in soils under different kinds of vegetal cover are presented for comparison in table 7.

TABLE 7.—*Chemical analyses of surface soils with the accumulated organic matter, from Oscoda County, Mich.*[1, 2]

Sample no. and soil type	Description	Loss on ignition	SiO_2	CaO	MgO	SO_3	Na_2O	K_2O	Fe_2O_3	Al_2O_3	MnO_4	TiO_2	P_2O_5
		Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
160. Nester silt loam.	Virgin forest of sugar maple, beech, and yellow birch. Litter, F layer humus. Not any A_2, or gray leached, horizon.	82.18	10.20	3.62	0.79	0.66	0.10	0.03	0.17	0.34	0.24	0.15	0.44
161. Grayling sand (driest phase).	Treeless. Thin cover of grasses, sedges, blueberries, etc. Frequently burned over. Thickness, 0 to 1 inch.	16.32	78.15	.98	----	.26	.38	.63	.73	2.34	.14	.15	.09
172. Roselawn sandy loam.	Second-growth oak forest. No evidence of recent burning. Thickness, 0 to 1 inch. More recent leaf fall excluded.	36.24	58.19	1.18	.56	.15	.42	.38	1.22	1.84	.24	.15	.18
163. Grayling sand..	Dense stand of jack pine, probably 40 years old. More recent needle fall excluded.	35.75	59.07	.82	.37	.33	.40	.17	.62	2.37	.07	.13	.16
164. Roselawn sand..	Scrubby second-growth aspen and oaks. More open than on Roselawn sandy loam. Has been severely burned over in the past.	10.65	84.18	.66	.46	.22	.63	.61	1.07	2.91	.22	.22	.11

[1] Analyst O. B. Winter, Michigan Agricultural Experiment Station.
[2] CO_2 included with loss on ignition.

The progressive changes in the present soil profile are probably toward continued leaching and, therefore, toward an increase in the thickness of the eluviated solum. In some of the sandy soils, the leaching process, resulting in the development of a gray layer beneath the forest mold, is as nearly complete as possible, at least in thickness, so that uninterrupted leaching would result in increment to the brown humic layer and further eluviation of the deeper layers. In the sandy clay material, the present processes if continued could be expected to result in the intensification of the brown humic layer and the further development of a B horizon through addition of clay, or in cementation and a consequent increase in a secondary layer of leaching between this and the brown humic layer. In the heaviest clays, there should be an increase in the thickness of the gray eluviated layer and subsequent intensification of the brown humic layer which at present is weakly developed.

In a glaciated region, such as the Lower Peninsula of Michigan where there is a comparatively thick covering of glacial drift from a variety of sources, with no relief features of magnitude and no sharply separated physiographic divisions, a blending or intergradation of soil types and also of the larger groups of soils would be predicted from these basic facts and from the postulations of pedology. A complete range exists in size of soil particles, from the finest measurable to stones; in soil of a given texture the amount of moisture is constantly gradational from a saturated or waterlogged condition of the land to the dryness of the jack pine sand plains; a wide range exists in the quantity of the separate elements and in the quantity of a particular compound, for example, calcium carbonate; and, finally, the degree of profile development ranges from practically no change in the parent material to the most maturely developed soil profile of the region. It follows, therefore, that in differentiating soil types, the permissible range or latitude in texture, moisture content, composition, and thickness, or their tangible expressions, must to some degree be arbitrary. From the nature of things, the soil type, the unit of soil mapping, as at present defined, is not permanently fixed quantitatively, but rather is empirical and is designed to meet the practical needs of a soil classification.

The various soil types differentiated in this county, taxonomically considered, are discussed in the following paragraphs.

Soils of the Roselawn series consist of yellow sand and light sandy loam to a depth of more than 3 feet. This material is underlain by a heterogeneous substratum of sandy drift. These soils are transitional in zonal character, differing but slightly from the Coloma soils of the southern part of the State. With increase in the lime and clay content, they grade imperceptibly into the Emmet soils. They are essentially sandy in texture, strongly acid in the solum, and contain a comparatively small quantity of limestone in the upper C horizon, although the deep substrata show little or no differences when compared with those of the Emmet soils.

The Grayling soils are essentially sands, both in the solum and in the C horizon, locally containing small quantities of gravel. They are pale yellow or gray, low in moisture content, strongly acid in the solum, and contain only a very small quantity of limestone in

the parent drift. The gray and brown layers are weakly developed. The soils of the Grayling, Rubicon, Saugatuck, and Newton series constitute a moisture series differing in degree of development of the gray and brown layers, the amount of organic matter in the surface soil, and the degree of bleaching, or leaching, but they grade into each other imperceptibly. All are sandy, and all are low in lime or strongly acid. Maximum eluviation in the gray layer and maximum cementation and thickness in the brown layer occur in the Saugatuck soils. The maximum accumulation of organic matter on the surface occurs in the Newton soils, in which the underlying sand is pale in color or bleached, owing to water-logging, and the brown layer, represented by pale-yellow or smoke-colored sand, is only feebly developed.

The Selkirk soils are heavy, very similar to the Ontonagon soils of northern Michigan, and might be regarded as a transitional phase of that soil, characterized by a less vivid red color in the B horizon.

The Emmet, Kalkaska, Roselawn, Grayling, and Rubicon soils constitute a series of sandy and gravelly soils, arranged according to the amount of clay and limestone in the parent material and the degree of acidity, the first containing the highest amount of limestone and clay. The visible difference between Emmet loamy sand and Roselawn sand is in the darker shade of color and higher percentage of colloids in the brown, or orterde, horizon; the difference between the Kalkaska soils and the Grayling and Rubicon soils likewise lies mainly in the darker shade of color and greater loaminess of the brown layer of the former and also the greater accumulation of organic matter on the surface.

The Bergland soils are underlain by a limy clay substratum the same as, or similar to, that underlying the Selkirk soils, but the Bergland soils have developed under poorer drainage. The Bergland is the northern analog of the Brookston. The Munuscong soils are closely related to the Bergland but have a thin cover of sand over the clay.

The Ogemaw soils have a thin covering of sand over clay and have developed under moderately poor drainage, but the Iosco soils have a thicker covering of sand and have developed with less water in the surface layers.

The Griffin soils comprise recent stream alluvium which is gray or light brown in color, with a variable amount of yellow or rust-colored spotting and streaking. The primary basis of differentiation is the high average moisture content, to the point of saturation at a slight depth. As throughout the State, there is a wide range in texture, in organic matter, and in mineral and chemical composition in these soils.

The organic soils, muck and peat, include five types or classes of material. Lupton muck includes the older, darker colored, more decomposed, and loamy muck which is in general nearly neutral in reaction and is underlain by deposits of peat more than 4 feet thick. Greenwood peat includes the raw, undecomposed, coarse-textured, yellow or brown, highly acid organic soil materials and in most places supports a heath-bog type of vegetation. Rifle peat occupies an intermediate position between Lupton muck and Greenwood peat in physical and chemical characteristics and depth of

water table. Houghton muck includes brown, dark-brown, or black, fibrous or stringy muck. Kerston muck is dark-colored muck or peat, with which a considerable amount of stream alluvium is intermixed.

The study of the native vegetation in relation to soil types has a purely scientific interest as a part of soil science and ecology, a significance in relation to problems of forestry and silviculture, and may have considerable value in determining the reconstruction of the original vegetal cover in detail. It has a direct application to agriculture in a region like this, because the vegetation can be used as a criterion, within certain evident limitations, of the agricultural value of the land and its crop adaptation; and further, it has a bearing on the cost and methods to be followed for the reclamation of cut-over land, inasmuch as the kind of stumps on the land and the present growth are known or may be inferred. The relation of soils and native vegetation in this county, based on observational studies, are presented in table 8.

TABLE 8.—*Correlation of soil types with vegetation in Oscoda County, Mich.*

Soil type	Present (1931) vegetation (wild land)	Original vegetation
Roselawn sand	Dominantly small or sprout growth of scarlet, white, and red oaks, with aspen (mainly *Populus grandidentata*), red maple, and fire cherry less abundant; a few red (Norway) pine; fair size and dense cover of oaks where land is unburned; sweetfern (*Comptonia asplenifolia*), bracken, blueberries, briers, grasses, low willow, and sumac common.	Dominantly red pine; hardwoods and a small proportion of white pine on the soils characterized by sandy clay in the substratum; a few scattered oaks in the original cover.
Grayling sand	Predominantly jack pine and small scattered growth of oaks; trees widely spaced, except in thickets of jack pine; bracken, sweetfern, blueberries, lichen, grasses, sedge, and low willow on more open land.	Red pine and jack pine; open land not densely forested, except for jack pine thickets; a few scattered oaks.
Rubicon sand	Oaks and aspen principally; jack pine, sweetfern, bracken, blueberries, willow, and wintergreen.	White pine and red pine, principal trees; probably a few hardwoods.
Roselawn sandy loam	Mainly fair-sized oaks, red maple, aspen, cherry, sumac, briers, grasses; open or moderately dense cover, depending on severity of fires.	Red pine and white pine numerous; hard maple, beech, elm, and hemlock on the more clayey areas.
Ogemaw sandy loam	Aspen (mainly *Populus tremuloides*), alder, and willow forming a dense cover; second growth of original cover in places.	White pine abundant; variable quantity of elm, ash, beech, hemlock, basswood, aspen, spruce, fir, and arborvitae.
Emmet sandy loam	Second growth of original species or dense growth of bluegrass and briers, with red maple sprouts, cherry, and aspen on the more severely burned-over land.	Dense forest of hard maple, beech, yellow birch, elm, hemlock, basswood, and a few scattered white pine.
Emmet loamy sand	Small trees of original forest left in slashings, together with luxuriant growth of grasses (mainly bluegrass) and briers, or mainly second-growth sugar maple; open stump land comprising red maple sprouts, cherry, aspen, and sumac, together with briers and grasses	Hard maple, beech, yellow birch, elm, hemlock, and white pine.
Iosco sandy loam	Red, white, and scarlet oaks, aspen, red maple, witch-hazel, bracken, sweetfern, and second-growth hardwoods in places:	White pine and red pine, hardwoods and hemlock in small bodies.
Saugatuck sand	Predominantly aspen and red maple; spruce, fir, and white cedar in the wetter places; dense cover of bracken, sweetfern, blueberries, and wintergreen.	White pine (dominant), aspen, spruce, fir, white cedar, red maple, yellow birch, ash, and elm.
Bergland clay loam	Second-growth aspen, spruce, fir, white cedar, elm, ash, basswood, white birch, alder, willow, sedges, rush (*Juncus*), and cattails.	Mixed conifer and hardwood forest consisting of elm, ash, basswood, red maple, aspen, white pine, hemlock, spruce, and fir.

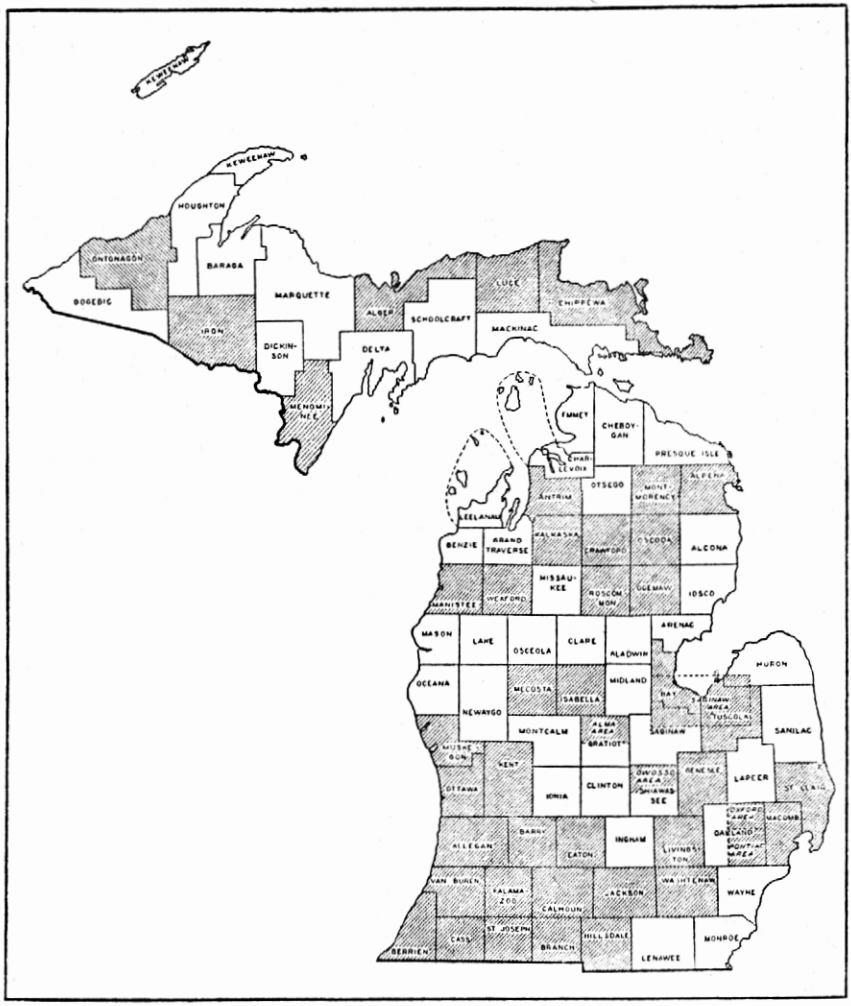
TABLE 8.—*Correlation of soil types with vegetation in Oscoda County, Mich.*—Continued

Soil type	Present (1931) vegetation (wild land)	Original vegetation
Newton sand	Dense cover of alder, willow, and aspen; scattered original forest trees.	White pine, spruce, fir, and white cedar, with less white birch, red maple, hemlock, aspen, and yellow birch.
Kalkaska loamy sand	Second-growth maple and elm chiefly; more severely burned-over land has aspen, fire cherry, red maple, a v scattered oaks; fairly heavy cover of grasses and briers.	Hard maple, beech, yellow birch, elm, hemlock, white pine, and probably a few oaks.
Selkirk silt loam and Nester silt loam.	Dense cover and good growth of aspen, with smaller proportion of conifers and hardwoods.	Elm, basswood, white spruce, black spruce, balsam fir, and white pine.
Munuscong sandy loam	Aspen, spruce, fir, cedar, alder, willow, with some ash, elm, red maple, white birch, and balm-of-Gilead poplar.	Swamp conifers and swamp hardwoods, with a few large white pine. Open marshy areas of sedges and grasses.
Granby gravelly sand	Spruce, fir, cedar, aspen, alder, and willow.	Swamp conifers and swamp hard woods, as ash, red maple, and balm-of-Gilead poplar.
Griffin sandy loam	Dense cover of elm, red maple, balm-of-Gilead poplar, ash, spruce, fir, cedar, aspen, alder, willow, and white birch.	In addition to present species, white pine and hemlock in greater numbers.
Kerston muck	Spruce, fir, cedar, aspen, alder, willow, very small amount of elm, oak, balm-of-Gilead poplar, red maple; open land, in places grass meadow.	Probably much the same species as at present.
Rifle peat	Cut-over coniferous swamp; white cedar, black spruce, tamarack; dense growth of alder, willow, sedge, grasses, leatherleaf, and various shrubs.	Dense growth of white cedar, black spruce, tamarack, and other plants as at present.
Lupton muck	Cut-over coniferous swamp; white cedar, spruce, fir, tamarack, balm-of-Gilead poplar, elm, and black ash.	Dense growth of white cedar, black spruce, tamarack, black ash, balm-of-Gilead poplar, elm, white pine, hemlock, and basswood.
Greenwood peat	Open heath bogs; leatherleaf, Labrador-tea, bog-rosemary (*Andromeda*), cranberry, sphagnum moss, and sedges; dwarfed growth of scattered black spruce and tamarack.	Presumably same as present growth.
Houghton muck	Sedges (*Carex* sp.) dominant, marsh grasses, flags, cattails, shrubby willow, aspen, and tamarack.	Probably same as present growth.

U. S. GOVERNMENT PRINTING OFFICE: 1936

Authority for printing soil survey reports in this form is carried in the Appropriation Act for the Department of Agriculture for the fiscal year ending June 30, 1933 (47 U. S. Stat., p. 612), as follows:

There shall be printed, as soon as the manuscript can be prepared with the necessary maps and illustrations to accompany it, a report on each soil area surveyed by the Bureau of Chemistry and Soils, Department of Agriculture, in the form of advance sheets bound in paper covers, of which not more than two hundred and fifty copies shall be for the use of each Senator from the State and not more than one thousand copies for the use of each Representative for the congressional district or districts in which a survey is made, the actual number to be determined on inquiry by the Secretary of Agriculture made to the aforesaid Senators and Representatives, and as many copies for the use of the Department of Agriculture as in the judgment of the Secretary of Agriculture are deemed necessary.



Areas surveyed in Michigan shown by shading. Detailed surveys shown by northeast-southwest hatching; reconnaissance surveys shown by northwest-southeast hatching.

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U. S. DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
HENRY G. KNIGHT, CHIEF
CHARLES E. KELLOGG, IN CHARGE SOIL SURVEY

SOIL MAP

OSCODA COUNTY
MICHIGAN

MICHIGAN AGRICULTURAL EXPERIMENT STATION
V. R. GARDNER, DIRECTOR
C. E. MILLAR, IN CHARGE SOIL SURVEY
MICHIGAN DEPARTMENT OF CONSERVATION
G. R. HOGARTH, DIRECTOR

R. 1 E. R. 2 E. R. 3 E. R. 4 E.

T. 28 N. T. 27 N. T. 26 N. T. 25 N.

MONTMORENCY CO. OSCODA CO. BOUNDARY LINE CRAWFORD CO. OSCODA CO. ALCONA CO. OSCODA CO. OSCODA CO. OGEMAW CO.

G R E E N W O O D

E L M E R

C L I N T O N

B I G C R E E K

H U R O N N A T I O N A L F O R E S T

C O M I N S

M E N T O R

LEGEND

Bergland clay loam — Bc	Munuscong sandy loam — Ms
Emmet loamy sand — El	Nester silt loam — Ne
Emmet sandy loam — Es	Newton sand — Nd
Granby gravelly sand — Gg	Ogemaw sandy loam — Os
Grayling loamy coarse sand — Gl	Roselawn sand — Rs
Grayling sand — Gs	Rs Gravelly phase
Gs Gravelly phase	Roselawn sandy loam — Ro
Griffin sandy loam — Gm	Rubicon sand — Ru
Griffin loam — Gr	Ru Gravelly phase
Iosco sandy loam — Is	Saugatuck sand — Ss
Kalkaska loamy sand — Kl	Selkirk silt loam — Sk
Houghton muck — Hm	Greenwood peat — Gp
Kerston muck — Km	Rifle peat — Rp
Lupton muck — Lm	

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort

Secondary roads and Trails

Railroads Steam and Electric

Bridges, Ferry

R.R. crossings, Tunnel

Ford, Dam

School or Church Cemeteries

Mine or Quarry Mine dumps Made land

Bluff, Escarpment, Rock outcrop and Triangulation station

Stony and Gravelly areas

Soil boundaries

Boundary lines

Boundary lines

Boundary lines

U.S. township and section lines

DRAINAGE
(Printed in blue)

Streams

Lakes, Ponds, Intermittent lakes

Intermittent streams

Springs, Canals and Ditches, Flumes

Swamp Salt marshes

Submerged marsh Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

Mark Baldwin, Inspector, District 1.
Soils surveyed by J. O. Veatch, Michigan Agricultural Experiment Station, in charge, L. R. Schoenmann and C. E. Millar, Michigan Department of Conservation, and A. E. Shearin, U. S. Department of Agriculture.

Scale 1 inch = 1 mile
1 ½ 0 1 2 3 4 Miles

BASE MAP FROM
MICHIGAN DEPARTMENT OF CONSERVATION
LAND-ECONOMIC SURVEY

WILLIAMS & HEINTZ CO., WASH., D. C.

Field Operations
Bureau of Chemistry and Soils
1931